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USE OF EMERGENCY ROOM PATIENT POPULATIONS IN AIR POLLUTION EPIDEMIOLOGY

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16. ABSTRACT

The long-term objective of this project was the design and implementation of a particular epidemiological approach to investigation of ambient pollutant effects: the correlation of pollutant exposure with patterns of hospital emergency room utilization. The report covers the initial phase of development and pilot studies. Separate discussions are provided on the two major components of the methodology: investigation of health effects and estimation of ambient ozone concentrations.

The approach to study adverse health effects was premised on the assumption that an increase in community morbidity due to environmental air pollution would be reflected in emergency room patient populations. It was concluded, however, that this was not a useful method for investigation of exposure-response associations.

The mapping of ambient ozone concentrations in time and space over the Riverside metropolitan area was investigated using data from two monitoring stations located within the subject area. A procedure was developed for a month-by-month comparative study of the data.

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USE OF EMERGENCY ROOM PATIENT POPULATIONS IN AIR POLLUTION EPIDEMIOLOGY

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FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The Health Effects Research Laboratory, Research Triangle Park, conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. These studies address problems in air pollution, non-ionizing radiation, environmental carcinogenesis and the toxicology of pesticides as well as other chemical pollutants. The Laboratory participates in the development and revision of air quality criteria documents on pollutants for which national ambient air quality standards exist or are proposed, provides the data for registration of new pesticides or proposed suspension of those already in use, conducts research on hazardous and toxic materials, and is primarily responsible for providing the health basis for non-ionizing radiation standards. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of health care and surveillance of persons having suffered imminent and substantial endangerment of their health.

The project described herein was a study of the feasibility of utilizing the frequency of hospital emergency room visits as a health end point in epidemiologic studies of air pollutants. Preliminary field testing of the methodology raised serious questions concerning the utility of this approach.

F. G. Hueter, Ph. D.
Acting Director,
Health Effects Research Laboratory

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Any errors in concept or presentation are the responsibility of the authors.

J.R. Ward
D.J. Moschandreas

INTRODUCTION AND SUMMARY

This is the final report on work accomplished under EPA Contract Number 68-02-2205, entitled "Effect of Short-Term Exposure to Indicated Emergency Levels of Ozone on Human Morbidity." The long-term objective of this project was the design and implementation of a particular epidemiological approach to investigation of ambient pollutant effects: the correlation of pollutant exposure with patterns of hospital emergency room utilization. Results from a preliminary field test of the methodology raised serious questions concerning the hypothesized cost and effectiveness of the proposed approach - subsequently, work was terminated.

The report covers the initial phase of development and pilot studies. Separate discussions are provided on the two major components of the methodology: investigation of health effects and estimation of ambient ozone concentrations. A summary of the research is presented in the paragraphs that follow.

Investigation of Health Effects

The approach to study of adverse health effects was premised on the assumption that an increase in community morbidity due to environmental air pollution would be reflected in emergency room patient populations. Proposed measures of this "effect" were changes in the number, proportion or severity of selected health conditions seen that corresponded with the prior occurrence of high ambient ozone concentrations. The conditions chosen for study were those which might result from either direct (irritative, biochemical) or indirect (stress) actions of ozone. The degree of change would be measured from a baseline determined after controlling for seasonal, day-of-the-week and other typical sources of variation. Lag time between exposure and response, and the measure of average or peak exposure, were to be treated as experimental variables in the analysis.

Patterns of emergency room utilization are influenced by many forces that are associated with facility characteristics, competing health services, and the responses of different patient groups to specific illness. In addition to fluctuations in community morbidity, these patterns may vary independently from facility to facility and from time to time. These factors combine to obscure the potentially small perturbation due to ozone effects that might be present, thus substantially elevating the relative risk of Type II error over a more controlled epidemiological approach. This risk indicated that the design must emphasize precision and cost-efficiency if it was to be advantageous.

For the preliminary field test, data were collected on patients seen at a county hospital which served as an areawide source of both emergency care and routine primary care. Matching seven-day periods were selected from every other month for October, 1974 through August, 1975. The emergency room log provided basic data for analysis of utilization patterns. In addition, small patient samples were drawn from the log to evaluate medical record abstracting and telephone followup procedures.

In reviewing results from the pilot study a number of problem areas were highlighted:

1. Differences in utilization patterns among the groups seeking care at the study facility that complicate their relationship with community incidence of illness.

2. Difficulty in categorization of presenting health problems in a manner which would achieve both pertinent representation of incidence and adequate sample size.

3. Insufficient clinical data to support resolution of diagnostic category and grading of severity.

4. Number of potentially important subclassifications of patients that may require separate attention in the analysis.

5. Difficulty in establishing the timing of symptoms relative to variation in ozone exposure levels.

On the positive side, the telephone interview was considered a useful tool for defining the patient's basic health status and exposure conditions.

Many of the technical problems explored are not unique to this approach, but could be better controlled through direct, continuous surveillance of a selected study population. It was judged that expansion to cover a number of emergency rooms and that prospective, detailed clinical data collection were necessary to optimize the opportunity for detecting pollutant effects by the proposed design. The increased complications and cost resulting from these changes would tend to negate the possible advantages of the original approach. Further, no factors were identified which would reduce the considerable risk of the Type II error that is associated with this design. Therefore it was concluded that further development of the approach would be unprofitable and that it did not offer a useful method for investigation of exposure-response associations.

Mapping of Ambient Ozone Concentrations

The mapping of ambient ozone concentrations in time and space over the Riverside metropolitan area has been investigated using data from two monitoring stations located within the subject area. A procedure was developed for a month-by-month comparative study of the data. The approach was based on the gradient of the hourly ozone concentrations and defined three characteristic units:

1. Two time periods - the "day" or structured hours, and the "night" or background hours;
2. Three types of "day" hours - Type I, II or III depending upon the ozone concentration gradient structures; and
3. Two geographic zones - the N-zone and the S-zone identified for days with large differences in hourly average ozone concentration at the two monitoring stations.

Analysis showed that the Riverside area may be divided in time and space zones for the study of pollutant concentrations. It should be pointed out that previous research on the subject considers the Riverside metropolitan area as one zone and utilizes average concentrations. Such premises would not fulfil the requirements of the present study.

Even though the ozone concentration gradient approach was designed to meet the specific needs of this study, the scheme developed is general. Furthermore, the gradient approach is straight forward, inexpensive and as reliable as the widely used, more complex photochemical models. It provides a time and space concentration grid without any simulation, and relies on only the ozone concentration gradients from the available monitoring data.

The ozone concentration gradient approach has been tested with data from a third monitoring station located within the subject area. Two conclusions have been reached from this "validation" effort:

1. The time and space grid developed from the two-station data favorably agrees with the respective divisions suggested by the inclusion of the third monitoring station; and
2. The mechanism can be applied to more than two stations, and naturally a given grid may be expected from the inclusion of more monitoring stations.

Details of this study appear in Part II of the report.

PART I - METHODOLOGY FOR INVESTIGATION OF HEALTH EFFECTS*

Section 1.0

PURPOSE AND OBJECTIVES

This is the final report under Contract Number 68-02-2205, "Effect of Short-Term Exposure to Indicated Emergency Levels of Ozone on Human Morbidity." Part I presents the study rationale and the results from a pilot test of procedures to measure health effects.

The general purpose of this project was to develop and test a methodology which would evaluate possible associations between ambient pollutant levels and utilization of medical care. More specifically, the objective was to design a survey approach which would provide first-order evidence of ozone-related morbidity and employ relatively low-cost data collection.

The first phase was concerned with construction and limited testing procedures. The field test was carried out to provide a preliminary appraisal of overall technical utility, before proceeding on to expanded phases of development and application. Appraisal of utility primarily involved questions of sensitivity and specificity in correlating adverse health effects with ambient ozone levels, given acceptable cost and operational characteristics, when compared to methods that provide for more direct surveillance of the exposed populations and for better control of interferring variables.

Part I describes the first phase of methodology design and field testing, excluding the approach to estimation of ambient pollutant levels (covered in Part II). Based on observations from the field tests an appraisal was made of study procedures, of requirements for further application, and of the potential for use in analysis of pollutant effects.

---

* Written by John R. Ward, M.S.P.H.

Section 2.0

BACKGROUND AND RATIONALE

Ozone (O_3) is the major component in a group of oxidants formed through a complex photochemical process from the action of sunlight on precurser agents, particularly those emitted in auto exhaust. This process is dependent on sunlight intensity, duration of sunlight, and air temperature. The amount of ozone is also dependent on the volume and balance of coexisting components which act as generating or reducing agents, as well as the usual meteorological and terrain factors which affect atmospheric concentrations of gases.

Concentrations of photochemical oxidants that are currently experienced during the summer months in many U.S. metropolitan areas are thought to present a hazard to human health. Ozone has been implicated primarily for its effect on structure and function of the respiratory system.[1] Animal studies have shown fibrosis of lung tissue, hemorrhaging, edema, and reduction in lung capacity. Other effects have included histamine production, radiomimetic blood changes, and general indications of stress.

Human studies have presented equivocal findings. Some respiratory impairment has been observed at exposures approximating high ambient air concentrations.[2] Correlations with reduced performance of athletes and with frequency of asthma attacks have been observed.[3] In terms of morbidity suggestive, but not definitive, correlations between ozone levels and frequency of hospital admissions for "relevant" illnesses (respiratory, cardiovascular) have been seen.[4] O_3 exposure at ambient levels has also been associated with severity of symptoms.[5] Other studies have not found an association with increased admissions among patients with chronic illness,[3] or with increased absences from school due to respiratory illness.[6]

In considering dose-response relationships, the available evidence suggests that environmental ozone concentrations reach those required to produce an observable acute reaction in the general population of the area. However, there are a number of factors which complicate study of dose-response through an epidemiological approach. Several of the most significant factors concern type and degree of response.

Ozone acts directly on the human organism as a respiratory irritant and secondarily through the stress of reduced pulmonary function. Individual sensitivity to these insults is considered to vary measurably with age and health status. Thus the very young, the elderly, and persons with asthma or inflamation of the respiratory tract are thought to be more vulnerable to irritant properties than healthy older children and young adults. The stress of reduced pulmonary function is a definite hazard to those persons with chronic obstructive lung disease, coronary problems or other illnesses where this additional physiological burden may exacerbate their condition. On the other hand, healthy persons may suffer no more than discomfort at the exposure levels experienced. This presents a wide spectrum of potential responses - from minor throat and eye irritation to heart attack and severe respiratory distress. Measurement of each type of response in turn has implications as to choice of the appropriate study population, the means of response measurement, the lag time for the response to occur, and control of confounding variables.

A second set of complicating factors is related to the extent and type of pollutant exposure. Outside the laboratory ozone will be encountered in combination with many other agents producing similar human responses to a greater or lesser degree. Those of main concern are O_3 precursors and other byproducts of auto emissions such as nitrogen dioxide, aldehydes and other photochemical oxidants, as these will occur simultaneously with ozone production. Additional common atmospheric pollutants such as sulphur dioxide and respirable particulates might be minimized by chosing study sites where these are not present in appreciable quantities or by choosing seasons when these agents are close to background levels. While carbon monoxide is not a respiratory irritant, this agent must also be taken into account, along with smoking and the mix of home and work exposures, in terms of the variation in continuous environmental insults. Finally, unusual occupational extremes must be identified when attempting to separate an association with ozone.

Three other aspects of dose are of particular concern. First, the ambient concentration which produces any statistical significant incidence of observable morbidity may be near the upper limits of environmental levels found, based on the results from laboratory studies. Even in such areas as the Los Angeles basin the number of days on which such peaks are experienced is limited. This combination may hinder detecting any increase in morbidity above normal incidence.

Second, little is known about the cumulative effects of persistent daily peaks. One might hypothesize that the repeated stress of moderate ozone maximum daily levels over a period of days might be as hazardous, or more so, than an extreme peak concentration on one day. In effect, repeated exposure may shift the distribution of responses to increase the frequency of the more severe reactions. Thus in relating illness to pollutant levels, it appears advisable to account for exposure history beyond the prior 24-hour period.

Third, there are serious questions regarding estimation of effective exposure from air measurement network readings. This includes the usual problems of determining the concentrations over areas between measurement points of an unstable gas under varying wind speeds and directions. Just as important is the degree of protection given by staying indoors. Thompson et al.[7] have shown that ozone levels in an air conditioned building may only reach half the outdoor concentration. Since most persons spend much of their time indoors, and the presumably most sensitive are routinely advised to stay inside during smog alerts, the group of most susceptible individuals actually exposed to high concentrations may be very small.

The factors discussed above suggest that a very large and/or highly selective study sample is necessary for an epidemiological investigation of ozone dose-response characteristics. They also dictate that care must be taken in determining exposure history, symptoms and their onset, baseline health status, and a number of concomitant variables that may influence either exposure or response. This in turn implies a requirement for relatively high-cost studies, with a considerable degree of risk in achieving definitive results. However, since field studies under natural conditions seem needed to better define the actual hazard posed, alternative study approaches which might minimize cost relative to the risk of achieving definite results should be examined.

One possibly useful methodology focuses on emergency room patients. This has several potential advantages:

- The study population is readily identified and a certain amount of pertinent data is available.
- Physician evaluation of the study subject's condition is available.
- A large proportion, perhaps the majority of persons in the community with severe changes in health status will be seen in emergency rooms.
- Most emergency rooms now serve as a routine source of 24-hour medical care for substantial segemnts of a community, providing for observation of a range of morbidity.

The key assumption here is that some representative proportion of at least the more severe responses to pollution exposure will be seen in emergency rooms. The cost of collecting basic data on response is low and could be done retrospectively.

The risk is that any changes in the emergency room patient population due to variations in ambient ozone concentrations may be too small to discriminate from other forces that control emergency room utilization, since only a small portion of the total community population affected will be seen. Further, even if a required sample size could be calculated, the study sample is limited to the actual number of emergency room arrivals and facilities in any particular geographic area. However, in research previously cited, suggestive correlations were found between hospital admissions and ozone levels. The emergency room population, while excluding most elective admissions, should on the other hand provide a broader study population base since patients in crisis who are either admitted, or treated and discharged, will be included.

One or both of two changes in emergency room patients due to ozone effects may be hypothesized:

- An increase in the number or proportion of arrivals with possibly exposure-related conditions (respiratory, coronary, etc.)
- A shift in severity of the cases seen, as indicated by either diagnostic parameters or the scope of care required.

Tests of either hypothesis are dependent on the quality of diagnosis and the extent of the diagnostic data. If the medical record is used as the data source, the completeness of documentation is also a factor.

It cannot be expected that medical charts will contain sufficient information for assessing exposure to ambient or occupational pollutants. While a quantitative estimate of the dose cannot be derived with accuracy, nominal differences in the degree and type of exposure should be identified for each patient. Remaining within a closed, air conditioned building during the day may provide substantial protection against effects of heat and ambient ozone levels. Continued significant occupational exposure may either potentiate or mask the effects of ambient pollutants. Such patient subgroups should be treated separately. To provide the required information it will be necessary to interview the patient or a family member familiar with the situation around the time of symptom onset.

An interview can also be a useful mechanism to collect details on exposure, on socioeconomic characteristics missing from the medical records, on symptom onset, and on the patient's condition prior to the emergency room visit. The last two items are considered important for several purposes. First, more complete and uniform information on timing of symptoms and course of illness relative to exposure can be obtained. Second, the degree of changes from baseline (usual) health status may provide further measures of severity of the illness episode. Finally, this information will provide some basis for identifying differences in utilization patterns among health facilities and among socioeconomic groups in the study community.

The interview could be conducted in the emergency room, on a visit to the patient's home, or by telephone. Emergency room interviews present logistical problems in that they may interfere with the care process and an interviewer must be available around-the-clock to identify and question selected patients. Household interviews are usually advantageous in terms of volume of data and completion rate, but can be very costly. Interviewing by telephone is dependent on the rate of success in contacting a suitable respondent but is probably the most rapid and least-cost approach for surveying a large group.

In summary it was judged that attempts to design improved methodology for population studies of pollutant effects should emphasize three goals:

1. Minimization of data collection costs, in light of the risk in achieving definitive results and the large sample required.
2. Achievement of more precise and complete delineation of variables defining patient characteristics, exposure history, and health status.
3. Focus on dimensions of health effects in addition to incidence of illness, such as variations in course and impact of morbidity.

The design and preliminary testing of an approach to these goals is presented in the following sections.

Section 3.0

PILOT STUDY DESIGN AND CONDUCT

3.1 SUMMARY OF DESIGN CONCEPTS

The general concepts discussed in Section 2.0 were implemented in a specific survey protocol. The designated target population was composed of selected patients seen in a hospital emergency room and residing within a defined service area. Initial selection was made retrospectively by presenting complaint and/or diagnosis, and by place of residence. The health problems used in selection were those which have been hypothesized to be potential clinical manifestations from exposures to photochemical oxidants, including both direct toxic reactions and secondary stress effects. Additional data on age, sex, and race were obtained from the log. The log data then provided basic utilization statistics on emergency room use. Distributions for the selected diagnoses and remaining arrivals were examined to determine the stability of patterns and trends by season. The total number of selected arrivals also served as the universe from which to draw samples for record abstracts and patient interviews.

In the second stage of the protocol, data on patient characteristics, clinical parameters, and disposition were abstracted from the patient's chart for a sample of selected problems. This data was intended for several purposes:

- To obtain more complete and accurate data on demographic characteristics, complaints, and diagnoses than appeared in the log

- To provide indications of onset of symptoms and severity of the illness at the time the patient was seen
- To obtain information needed to contact the patient for an interview.

A number of parameters were included in the abstract which might indicate severity of the patient's condition: nature of symptoms, vital signs, physician's observations, values of particular diagnostic tests, level of treatment provided, type of disposition from the emergency room. If the data proved to be adequate, an objective classification scheme could be worked out for each selected problem; otherwise either physician judgment in each case or simple categories based on disposition would be necessary. Interpretation of patient status based on procedures must be done with caution as these reflect individual hospital policies and practices.

The third stage of the protocol called for interview of the patient or a knowledgable respondent by telephone. Basic information for tracing the patient was obtained from registration forms and other records in the patient's chart and repeated attempts to contact a respondent at home or work were made, following standard procedures. Much of the interview focused on variables related to exposure: usual activity patterns; conditions at home, work, or school; activities prior to onset of symptoms; and length of residence. The second major topic concerned questions about health status, including chronic illness and changes in functional capacity after onset of symptoms. Still other items were related to use of the emergency room.

The data instruments and the detailed data collection procedures used are provided in the appendix.

3.2 CONDUCT OF THE FIELD TEST

A field test was carried out during September-October 1975 with the primary aim of evaluating the procedures presented in the appendix. The specific purposes of the field test were to determine estimates of:

- Time, cost, and difficulty of data collection
- Availability of medical record data
- Success in obtaining interview data
- Utility of study concepts employed.

A key issue was the probable success of this approach in producing definitive statements concerning human effects from short-term exposure, considering the relative cost of alternative approaches and the inherent problems of detecting ozone-related effects in this target population.

3.2.1 Description of Study Site

The Riverside, California area, in the eastern portion of the Los Angeles Basin, was selected for study. This area experiences some of the highest seasonal ozone levels in the U.S., has a large population, and is covered by a fairly comprehensive air quality monitoring network. Riverside residents are also subjected to unusual exposure phenomena which frequently sustain high ozone concentrations over the majority of daylight hours. (The reader will find a detailed description of pollutant behavior in Part II.) This area appeared to present suitable conditions for pursuing the project through pilot and feasibility studies to a full-scale investigation.

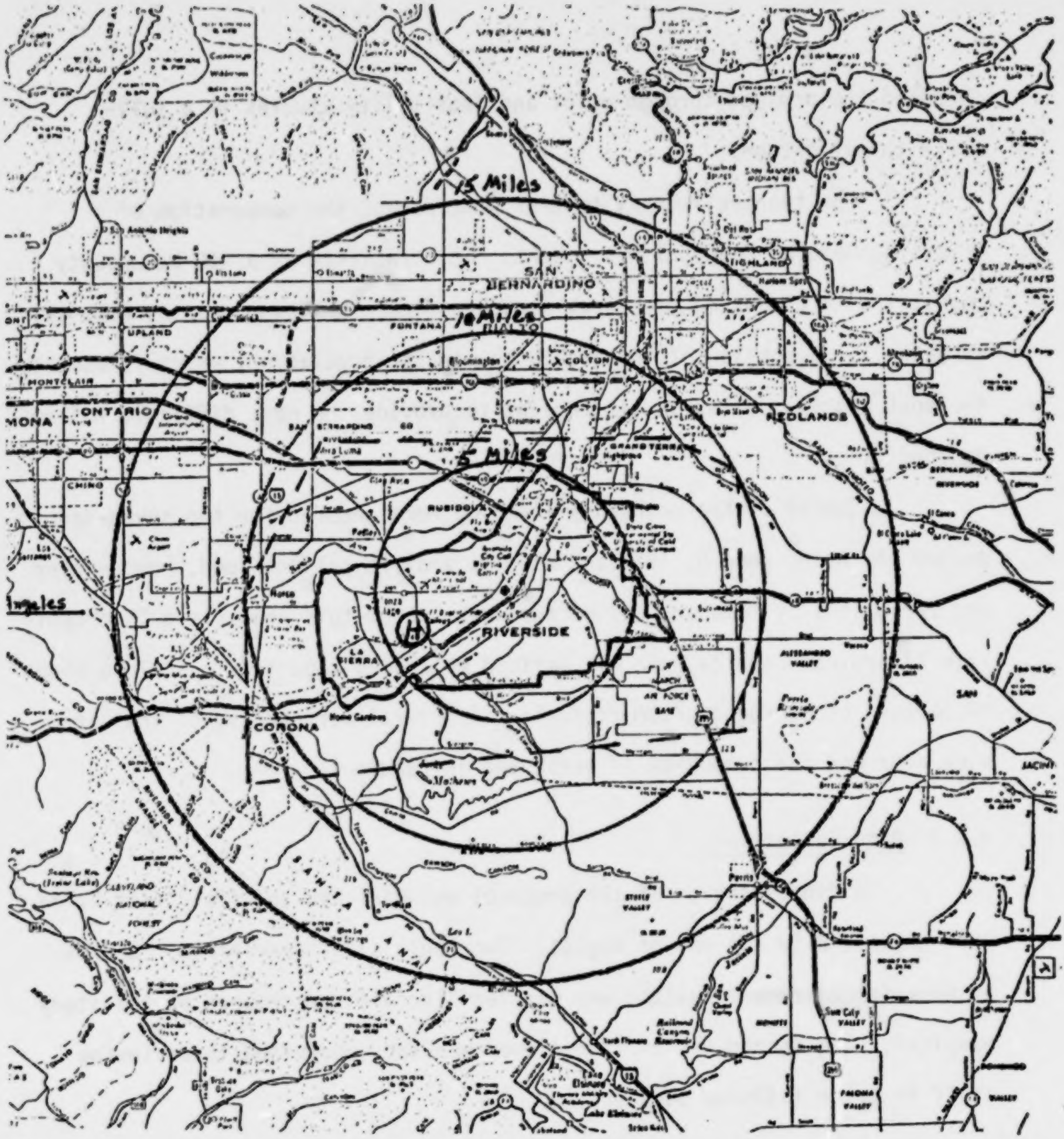
For the preliminary test of procedures, the cooperation of Riverside General Hospital was sought. This facility is a 400-bed county hospital with organized emergency and outpatient services. As the hospital serves a large portion of the area's low-income population, which is usually the most highly mobile, it was thought to provide the most difficult follow-up conditions.

Copies of the emergency room log were secured for the seven-day period beginning June 9, 1975 and used to analyze patient load, composition and variations by time and day of the week. From this analysis a "Metropolitan Riverside" service area was defined which was expected to include about 80 percent of emergency room arrivals. A general perspective of the service area and the community is presented in Figure 1.

3.2.2 Data Collection

A final version of the protocol was finished and field activities were organized by the end of August. Two field staff were hired. One was an experienced record analyst who was familiar with procedures at the study hospital. The second was an interviewer who had supervised interviewing staff in prior followup surveys.

Using photocopies of the emergency room log (with names deleted), all patients with specific diagnoses (or specific complaints, if no diagnosis was listed) were marked for matching seven-day periods in every other month, starting with October 1974 and ending with August 1975. Diagnoses and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GRAND TERRACE
RUBIDOUX
RIVERSIDE
LA SIERRA
CORONA
Home Gardens
Ingeles
AIR FORCE BASE
Perris
SAN
JACINT

Key:

H: Riverside General Hospital
_ _ _: RGH Metro Service Area
_____: Riverside City Limits
15 Miles: Distance from Center of Riverside

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Figure 1. General Perspective of the Service Area and Community

complaints included are listed in Table 1. These specific times were picked to represent each season of the past year and to standardize emergency room utilization by day of the week. Log records were coded for each case identified.

A systematic sample was chosen from the identified cases to provide 50 patients from each weekly period for medical record abstracting. The quota of common diagnoses, such as upper respiratory infections, was limited to allow the less frequent problems to enter the sample.

For a test of interview procedures, every other case in the abstract sample was selected for the months of February, April, June, and August of 1975. A reduced sample was used because of the time requirements expects for this task. The time spread was picked to investigate problems in recall and followup with elapsed time.

Further information on the procedures used is presented in the appendix. The next section discusses results of the pilot study.

Table 1. Diagnoses and Complaints for Sample Selection

Selected E.R. Diagnoses	
Nervous System and Sense Organs	
	Eye Irritations, Conjunctivitis
	Otitis Media*
	Convulsive Disorders, Idiopathic Seizures
Respiratory System	
	URI, Colds, Tonsillitis, Sinus, Allergy
	Flu, Viral Syndrome*
	Acute Bronchitis, Pneumonia, Pleurisy*
	Asthma*
	COPD, Chronic Bronchitis, Emphysema*
Circulatory System	
	Cardiovascular Disorders
	Cerebrovascular Disorders
	Hypertension
Gastrointestinal System	
	Gastroenteritis, Gastritis
	Ulcers (Upper GI)
Other Selected Diagnoses	
	Diabetes
	Hepatitis, Hepatic Disorders
	Psychiatric Disorders (Excluding O.D.)

Selected Symptoms Not Included with Above Diagnoses
Chills, Fever
Fatigue, Weakness, Fainting, Dizziness
Dehydration, Fluid Imbalance
Coma, Stupor, Unconciousness
Headache
Convulsions, Seizures
SOB, Breathing Difficulty, Hyperventilation
Chest Pain, Congestion, Cough
Sore Throat
Abdominal Pain, Cramps
Diarrhea, Nausea, Vomiting
Jaundice
Depression, Nerves, Abnormal Behavior
Epistaxis w/o Injury

* With or without URI.

Section 4.0

RESULTS FROM THE FIELD TEST

4.1 EMERGENCY ROOM UTILIZATION PATTERNS

The emergency room log maintained by the study hospital was used as the source of data for description of utilization patterns. For six selected seven-day periods, all patients with certain diagnoses (or complaints) and residing within the designated hospital service area, were identified. The following log entries were then coded for each patient identified:

- Month and day of the visit
- Whether discharged from the E.R. or admitted to hospital
- Age, sex, and ethnic group
- Recorded complaints or problems and diagnoses
- City of residence.

Age and residence were coded also for the remaining patients. The log data were tabulated to estimate the volume of patients available in each diagnostic category and to identify significant daily and monthly variations in composition of the population seen.

One aim of the methodology is evaluating statistical associations between ambient O_3 concentrations and the number and proportion of patients seen with specific medical conditions. Variation in the number of patients seen may reflect either fluctuations in incidence of that condition among the service population or changes in size and/or composition of the population in the service area. The latter factors may affect the number of susceptibles, the number using emergency rooms as the source of care, or the number of cases with other medical conditions. These are exogenous influences which may obscure patterns due to any single specific cause. The degree of these changes and of their impact on emergency room utilization cannot be conclusively determined from data on patients seen. One is limited to assumptions that may be supported by the analysis, and by general knowledge of the service area, as to the importance of exogenous factors.

Tables 2 and 3 present distributions of total emergency room arrivals (i.e., selected patients plus other patients). The last week in each month has been chosen to control for any consistent variations within months. In Table 2 the maximum difference in weekly totals is between February (551) and August (622), representing a difference in average per day of only 10 patients. The number of arrivals for each day of the week is fairly consistent month-by-month, with the exception of those values noted by an asterisk. If the exceptions are excluded, differences in the adjusted averages among months are smaller. Also daily totals by day of the week cluster more closely around the average. Usually Monday is the busiest day of the week and Sunday the slowest. Based on the adjusted averages, differences among months are not substantial.

In Table 3 total arrivals are distributed by age group and residence for each month. "Riverside" refers to that city while "Other Metro" refers to other communities within the designated service area. The

Table 2. Total E.R. Arrivals by Day of the Week and Month of E.R. Visit: Metropolitan Area Patients, Selected Weeks, October 1974 Through August 1975

	October	December	February	April	June	August	Total	Average Per Day	Adjusted Average*
Monday	97	110	106	103	99	108	623	104	104
Tuesday	103*	89	71	83	79	73	498	83	79
Wednesday	75	46	99	90	75	92	477	80	80
Thursday	83	96	83	75	78	108*	523	87	83
Friday	80	83	90	81	68*	89	491	82	85
Saturday	87	80	79	70	101*	75	492	82	78
Sunday	65	73	23*	72	76	77	386	64	73
Total	590	577	551	574	576	622			
Average Per Day	84	82	79	82	82	89			
Adjusted Average*	81	82	88	82	79	86			

* Days marked with asterisk excluded in adjusted average.

Table 3. Total E.R. Arrivals by Age and Month: Riverside and Other Metro Area Patients, Selected Weeks, October 1974 Through August 1975*

Month	Under 2		2-5		6-17		18-44		45-64		65+		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Riverside														
October	25	5.3	18	3.8	76	16.0	251	52.7	76	16.0	30	6.3	476	100.0
December	26	5.4	20	4.2	70	14.6	271	56.3	64	13.3	30	6.2	481	100.0
February	31	6.5	33	6.9	77	16.0	235	49.0	70	14.6	34	7.1	480	100.0
April	13	2.7	14	2.9	82	17.1	258	53.7	81	16.9	32	6.7	480	100.0
June	20	4.2	18	3.8	65	13.7	280	59.1	58	12.2	33	7.0	474	100.0
August	21	4.1	23	4.5	68	13.2	290	56.4	84	16.3	28	5.4	514	100.0
Total	136	4.7	126	4.3	438	15.1	1585	54.6	433	14.9	187	6.4	2905	100.0
Average by Age	23		21		73		264		72		31		484	
Range	13-31		14-33		65-82		235-290		58-84		28-34		476-514	
Other Metro Area														
October	4	3.5	8	7.0	20	17.5	66	57.9	14	12.3	2	1.8	114	100.0
December	12	12.9	5	5.4	8	8.6	54	58.1	12	12.9	2	2.2	93	100.0
February	9	12.7	4	5.6	9	12.7	39	54.9	8	11.3	2	2.8	71	100.0
April	6	6.5	4	4.3	15	16.3	47	51.1	14	15.2	6	6.5	92	100.0
June	5	5.3	7	7.4	14	14.7	53	55.8	10	10.5	6	6.3	95	100.0
August	5	4.8	8	7.7	19	18.3	58	55.8	8	7.7	6	5.8	104	100.0
Total	41	7.2	36	6.3	85	14.9	317	55.7	66	11.6	24	4.2	569	100.0
Average by Age	7		6		14		53		11		4		95	
Range	4-12		4-8		8-20		39-66		8-14		2-6		71-114	

* Excludes 16 unknown ages.

classification is based on the postal address. For Riverside residents only the month of August is exceptional in overall utilization. The variation among months seen in Table 2 is accounted for largely by fluctuations in numbers of "Other Metro" residents. Within age groups there are notable differences in the number of patients by month but differences in percent of total arrivals are remarkable only for "Other Metro" patients.

This cursory review suggests that there is a fairly stable service population of Riverside residents. This is consistent with the observations that this public hospital serves as a major source of care for area low-income residents and that access to outpatient clinics is through the emergency room. There are competing sources of care for patients residing on the fringes of the service area so that there may be more selectivity in use of care facilities.

If these interpretations are correct, they have three important implications. First, fluctuations in use by Riverside residents may reflect incidence of medical conditions - which benefits the study approach. Second, use by "Other Metro" residents indicates that competing sources of care - emergency rooms and perhaps other primary care facilities - would have to be included in the study in order to detect the effects of ambient oxidant levels on these groups. Finally, the small differences in utilization by Riverside residents from month to month and season to season, implies that measure of oxidant effects may likely depend on the occurrence of sufficient proportional changes among diagnoses and/or in severity or other perhaps subtle characteristics of the patient's condition, as opposed to a substantial increase in relevant conditions following high O_3 levels. To explore the last point, the tables following present data on diagnostic distributions.

Table 4 shows the number of cases seen by month of the conditions selected as possibly relevant for detection of O_3 effects. (H-ICDA codes included in each condition group are given in Table 5). The rate per 100 total arrivals for each condition is also provided in Table 4.

The conditions listed were from the diagnoses entered in the E.R. log or, if no diagnosis was given, the patient complaints entered were used. All conditions of interest were included, and there may be several conditions tabulated for a patient. The reader will note from Table 5 that a number of artibrary classifications were made. For example, chest pain and abdominal pain without diagnosis were included in respiratory disorder and gastrointestinal disorder, respectively. In contrast chills or fever and headache or dizziness are shown separately, as is eye irritation. These complaints, and chest or abdominal symptoms, were of course frequently present for diagnoses of respiratory infection, flu, or viral syndrome. Similarly multiple, related diseases were often entered: URI and otitis, URI and flu, URI and gastroenteritis, etc. Some cases with respiratory symptoms were diagnosed as URI, others as flu or viral syndrome. This situation prohibits unequivocal classification of these patients into discrete categories related to etiology. With these qualifications, data in Table 4 are an attempt to determine volume of conditions available and any trends in time.

Table 4. Selected Conditions, Number and Rate* Per 100 Patients: Riverside and Other Metro Area Residents, Selected Weeks, October 1974 Through August 1975

Diagnosis Group**		October		December		February		April		June		August	
		Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Respiratory Disorders (1-6)	R	78	16.4	98	20.4	104	21.7	66	13.8	69	14.6	72	14.0
	O	11	9.6	26	30.0	18	25.4	8	8.7	17	17.9	15	14.4
Otitis (7)	R	9	1.9	9	1.9	18	3.8	8	1.7	7	1.5	12	2.3
	O	3	2.6	7	7.5	2	2.8	1	1.1	1	1.1	4	3.8
Eye Irritation (8)	R	2	1	2	1	1	1	3	1	2	1	4	1
	O	-	-	-	-	-	-	-	-	-	-	-	-
Chills, Fever (10)	R	3	1	2	1	-	-	-	-	1	1	-	-
	O	-	-	-	-	-	-	-	-	-	-	-	-
Headache, Dizzyness (11)	R	9	1.9	6	1.2	10	2.1	13	2.7	4	1	13	2.5
	O	6	5.3	2	2.2	-	-	3	3.3	-	-	1	1
Vascular Disorders (12-14)	R	16	3.4	17	3.5	12	2.5	12	2.5	10	2.1	15	2.9
	O	3	2.6	1	1.1	2	2.8	2	2.2	1	1.1	3	2.9
Mental Disorders (15-16)	R	23	4.8	28	5.8	32	6.7	30	6.2	31	6.5	41	8.0
	O	6	5.3	2	2.2	5	7.0	5	5.4	3	3.2	5	4.8
Seizure Disorders (17)	R	5	1.1	3	1	1	1	8	1.7	7	1.5	6	1.2
	O	1	1	1	1.1	1	1.4	-	-	2	2.1	-	-
Diabetes Mellitus (18)	R	8	1.7	1	1	6	1.2	3	1	4	1	4	1
	O	-	-	-	1.1	-	-	-	-	1	1.1	-	-
Gastrointestinal Disorders (19-21)	R	22	4.6	26	5.4	20	4.2	12	2.5	21	4.4	31	6.0
	O	8	7.0	6	6.5	-	-	5	5.4	9	9.5	7	6.7
Flu, Virus (9)	R	14	2.9	7	1.5	12	2.5	6	1.2	4	1	8	1.6
	O	-	-	-	-	-	-	2	2.2	2	2.1	1	1
Total Patients	R	476		481		480		480		474		514	
	O	114		93		71		92		95		104	

* 1 is 1.0/100 arrivals.

** Numbers in parentheses refer to categories in Figure 3.

R - Riverside City

O - Other Metro Area

Table 5. Definitions of Diagnosis Groups Used in Analysis

Diagnostic Group	H-ICDA Codes
1. Asthma	4930-4939
2. Chronic Respiratory Disease: Chronic Bronchitis, Emphysems, Chronic Obstructive Lung Disease	4910-4929, 4960
3. Acute Lower Respiratory Disease: Pneumonia, Bronchitis, Pleurisy, Acute Pulmonary Edema	4800-4869, 4890-4909, 5110, 5119, 5191
4. Lower Respiratory Symptoms: Pulmonary Congestion, Chest Pain, Respiratory Difficulty, Lower Respiratory Symptoms	5140, 5149, 5197, 7740, 7780-7789, 7790-7791, 7793, 7794, 7963, 7968
5. Acute Upper Respiratory Disease: Septic Sore Throat, Acute Upper Respiratory Infections, Peritonsillitis	0340, 4600-4659, 501
6. Upper Respiratory Symptoms: Chronic Pharyngitis, Allergy, Earache, Nasal Congestion, Sore Throat	5020-5039, 5070, 7720-7722, 7760-7769, 7776-7777
7. Otitis Media, Otitis Externa	380, 381
8. Eye Irritation: Conjunctivitis, Blephoritis, Inflammation and Soreness	0789, 3600-3619, 7711
9. Flu: Influenza, Viral Syndrome	0799, 4700
10. Chills, Fever	7922, 7929
11. Vertigo, Dizziness, Headache: (Migraine, Tension, Other)	7704-7705, 7920, 3168, 346
12. Cardiovascular Disorders and Symptoms	4100-4299, 7741-7746, 7750, 7755
13. Cerebrovascular Disorders	4300-4389
14. Hypertension and Elevated Blood Pressure	4000-4059, 7747
15. Nonphysical Psychoses and Personality Disorders	3060-3099, 3110-3119, 3169
16. Anxiety, Depression, Nerves, Neuroses	3100, 3105, 3109, 317, 7926
17. Epilepsy, Convulsions, Seizures	3450-3459, 7703
18. Diabetes Mellitus	2500-2509
19. Upper G.I. Ulcers, G.I. Bleeding	5310-5349, 7820
20. Gastroenteritis, Gastritis, Diarrheal Disease	0080-0099, 5350-5351, 7821
21. Abdominal Symptoms: Pain, Nausea, Vomiting, Flatulence	5369, 7800-7801, 7816, 7823, 7824

Several observations from Table 4 appear relevant to study objectives. Grouped in this manner, respiratory disorders is the predominate category and the only category with a discernable seasonal trend. The winter increase in respiratory illness is consistent with a study of hospital admissions by the local health department and represents the "flu" season in this area. Ambiguity in classification, in combination with the small numbers, obscures possible patterns for other disorders. If typically high- and low-oxidant periods are compared (August and April, respectively), there are a few categories which suggest any contrast in frequency. If one considers that these data are totals for a seven-day period, the low frequency in many diagnostic categories combined with the lack of marked differences among months do not encourage use of these diagnoses in the study.

Since they comprise the largest category, Tables 6 through 8 examine distributions of respiratory and related disorders. Otitis and flu/viral diseases have been included as they were frequently present in combination with conditions classified as respiratory disorders. For convenience, the general label of "respiratory" conditions is used.

Table 6 shows the number seen and rate by age group. Age is known to be associated with incidence of the various disorders and with utilization of health services. Age is also thought to reflect differences in sensitivity to oxidants. Comparing the number of conditions among age groups is not helpful since the numbers are affected by variation in the number of patients seen. Rates are computed using total patients in each cell as the base.

Table 6. Respiratory and Related Conditions by Age and Month, Number and Rate* Per 100 Patients: Metro Area Residents, Selected Weeks, October 1974 Through August 1975

	October	December	February	April	June	August
Under 2 Years	16	32	27	11	16	12
Rate	55.2	84.2	67.5	57.9	64.0	46.2
2 - 5 Years	11	19	22	8	7	15
Rate	42.3	76.0	59.5	44.4	28.0	48.4
6 - 17 Years	22	16	25	12	17	12
Rate	22.9	20.5	29.1	12.4	21.5	13.8
18 - 44 Years	43	63	51	37	49	45
Rate	13.6	19.4	18.6	12.1	14.7	12.9
45 - 64 Years	12	11	16	12	5	19
Rate	13.3	14.5	20.5	12.6	7.4	20.7
65 + Years	2	2	7	7	3	4
Rate	6.2	6.2	19.4	18.4	7.7	11.8
All Ages**	106	144	148	88	97	107
Rate	18.0	25.0	26.9	15.3	16.8	17.2
Riverside**	95	111	128	77	78	87
Rate	19.9	22.8	26.7	15.9	16.2	16.8
Other Metro**	11	33	20	11	19	20
Rate	9.7	36.3	28.2	12.2	19.8	19.4

* Rate = Total Cases/Total Patients in Cell x 100

** Excludes unknown age.

The highest rates of respiratory conditions in all age groups occurred in one or both of the winter months. There was a general decrease in the rate of these conditions with increasing age, which was most prominent for the winter months - reflecting the higher incidence of acute respiratory infections in winter months, particularly among the younger ages. The rates also show the relative importance of respiratory conditions among all conditions by age. For example, in those under two years these conditions were diagnosed in 46-84 percent of the patients seen, while in those patients age 65 or older they accounted for 6-19 percent of the diagnoses. The two bottom rows of this table further illustrate differences in distributions between Riverside and Other Metro residents seen earlier.

Table 7 presents data on categories of respiratory and related conditions for Riverside residents only. Rates are computed using a base of all patients with these conditions, rather than total arrivals as before. The bottom rows of the table compare the number of conditions and actual number of patients, and indicate the percentage of total arrivals with diagnoses of respiratory and related conditions.

One percent of all arrivals averaged about five patients for the periods studied. Considering percent of total patients, respiratory conditions accounted for the majority of the variation in total arrivals during each period. Increased utilization in the winter months is due to a higher incidence of acute conditions - there were also more patients with a combination of diagnoses. For April, June, and August the number of patients and the proportion of total arrivals was about equal. This provided an

Table 7. Respiratory and Related Conditions, Number and Rate* Per 100 Patients: Riverside Residents, Selected Weeks, October 1974 Through August 1975

Diagnosis	Number and Rate/100 Patients											
	October		December		February		April		June		August	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Asthma	7	7.2	7	6.5	5	4.1	6	7.7	6	7.8	5	6.2
Chronic Respiratory Disease	-	-	2	1.9	4	3.3	1	1.3	3	3.4	4	4.9
Acute Lower Respiratory Disease and Symptoms	16	16.5	17	15.9	19	15.6	18	23.1	10	13.0	14	17.3
Acute Upper Respiratory Disease and Symptoms	55	56.7	72	67.3	76	62.3	41	52.6	50	64.9	49	60.5
Otitis	9	9.3	9	8.4	18	14.8	8	10.3	7	9.1	12	14.8
Flu, Virus	14	14.4	7	6.5	12	9.8	6	7.7	4	5.2	8	9.9
Total Conditions	101		114		134		80		80		92	
Patients: Number	97		107		122		78		77		81	
Percent of Total**	20.4		22.2		25.4		16.3		16.2			15.8

* Patients seen with respiratory and related diagnoses.

** All arrivals.

Table 8. Respiratory and Related Conditions, Percentage Distribution by Month: Riverside Residents, Selected Weeks, October 1974 Through August 1975

	October	December	February	April	June	August	Total	
							Number	Percent
Asthma	19.4	19.4	13.9	16.7	16.7	13.9	36	100.0
Chronic Respiratory Disease	0.0	14.3	28.6	7.1	21.4	28.6	14	100.0
Acute Lower Respiratory Disease and Symptoms	17.5	17.5	22.5	18.7	10.0	13.8	80	100.0
Acute Upper Respiratory Disease and Symptoms	16.0	21.0	22.2	12.0	14.6	14.3	343	100.0
Otitis Media	9.6	17.3	25.0	15.4	13.5	19.2	52	100.0
Flu, Virus	27.5	13.7	23.5	11.8	7.8	15.7	51	100.0

opportunity to view changes in the relative rates among categories. It is seen that rates vary both as a function of the number of patients in each category and of the proportion represented by acute upper respiratory conditions per patient. Multiple conditions are more prominent in August.

In Table 8 comparisons among diagnosis categories are shown from another perspective. Generally, the largest percentage of conditions in all categories occurred during the winter months. The exceptions were cases of flu or viral diseases seen in October. With the small numbers of observations it cannot be judged whether the higher frequency was an artifact or represented a real increase in incidence.

The review presented in Section 4.1 represents one component in preliminary evaluation of the proposed approach. The purpose was to identify characteristics of emergency room utilization that may have implications for further development and application of the technical approach. By intention, this pilot study was limited, which in turn restricted the reliability and scope of interpretations drawn from the data. The interpretations made were largely subjective and they were meant to suggest factors that, if correctly perceived, would be significant in judging the utility of the approach. Points that appear important in this preliminary evaluation are summarized below.

When certain exceptional days were excluded, overall utilization by day of the week was remarkably consistent across months. Much of the variation in total arrivals were due to differences in volume of "Other Metro" residents. Comparisons of these patients with Riverside residents showed differences by age and by groups of selected conditions. Variations from period to period among Riverside residents was relatively small and the largest proportion of differences was accounted for by fluctuations in acute respiratory and related illness. The usual increase in respiratory illness during the local "flu" season was seen, although individual patterns of occurrence among the various respiratory diagnoses seemed to be present. The number of respiratory conditions did not always vary proportionately to the number of patients; i.e., in some periods there were more patients with a combination of diagnoses than in other periods. Seasonal patterns for other diagnosis groups were not apparent.

The seasonal influence in respiratory illness among "Other Metro" residents was observed, similar to Riverside residents, and patterns of rates which varied from those of Riverside patients could have been affected by the small number of cases. However, more selectivity in use of competing care resources should be considered for "Other Metro" residents - that is, the assumption of proportional community representation was supported to a degree for Riverside residents but was not judged so for residents of other parts of the designiated service area for this emergency room. This indicates that the study population for explaining environmental effects must either by limited to Riverside patients or be expanded to include other competing service facilities outside of the city.

Distributions of patients and conditions by diagnosis suggested several implications for further study. First, aggregated groups of conditions may obscure contrasting patterns for the individual diagnoses. Second, although daily variations by diagnosis were not explored, the fairly uniform weekly totals across months in combination with the small number of cases available seemed to limit the opportunity to establish either an association or lack of association with environmental factors for many conditions. Limiting the study to this one facility may restrict the investigation to only acute respiratory conditions. Otherwise an increased sample obtained from other facilities would be necessary.

4.2 EVALUATION OF MEDICAL RECORD DATA

In a full-scale application of the methodology an abstract of the medical record would serve as the basic source for analysis of patient characteristics and clinical parameters. The emergency room log would be used only for preliminary identification of the patient sample and to develop statistics on overall utilization. However, for the pilot study a small number of medical records (about 50 per weekly period) was chosen for abstracting, with the limited purposes of evaluating the procedures and the availability of various data items contained in the abstract.

The proposed methodology relied on medical record entries to provide the data for classifying individuals into analytical groups, for establishing the timing and duration of symptoms, and for facilitating patient followup. Three general types of patient classification were intended:

> Health effects - classification of presenting health problems into discrete categories which permits testing of associations relevant to mechanisms of induction by ozone and other environmental factors. Pertinent data items were complaints, symptoms, diagnosis, medical history.

> Susceptability - classification of patients into categories which may relate to differentials in disease incidence, in proclivity to seek emergency room care, or in sensitivity to environmental factors. Pertinent data items were age, sex, race, family income, residence, disease history, functional status, utilization history.
>
> Severity - classification of patients into categories which defines gradations in response to pathophysiological mechanisms, within the overall health problem category. Such "severity" levels might be defined by diagnostic tests, reported functional status, or variations in the intensity of care required. Pertinent data items were test results, entries describing condition of the patient, type of therapy, and disposition.

For the first two classifications the degree of resolution permitted by the data is clearly critical in this approach as well as other epidemiological techniques of studying pollutant effects. Even in the general category of respiratory illness ambiguity in classifying the response and/or the patient can easily obscure small increments in incidence due to the cause of interest.

The third classification - severity - was to be used for two purposes if feasible: detection of shifts in average severity among patients following ozone alerts, and possibly, to identify differentials in tendency to seek care among diagnostic groups and among patient populations using the various emergency facilities in the area. The concept of severity measurement was considered experimental and of potential utility, although not highly critical to the success of the approach.

The availability of medical record data is summarized in Table 9. Basic items for health effects and susceptability classification were

Table 9. Summary Evaluation of Medical Record Data

Data Item	Observations on Availability
Demographic Data	Age, sex, race, present for 95 percent of patients.
Residence	Address, telephone of patient or alternative contact usually available.
Symptoms, Complaints	Major complaints usually listed, plus symptoms noted by the physician. Onset by complaint not always clear, and duration of complaint missing in 35 percent of respiratory conditions sampled.
Medical History	Usually limited on E.R. record to symptom onset. More general history available for large proportion of patients seen in OPD.
Severity of Condition	Specific mention in record for some critical cases.
Vital Signs	All four usually recorded, except blood pressure for children.
Diagnostic Test Data (Selected Tests)	X-rays usually for chest complaints. Selected lab tests infrequently done.
Treatment (Selected)	Except for injections, selected therapeutic measures rarely employed.
Diagnosis	Tentative diagnosis usually entered.
Disposition	Low rate of admissions. Entry for disposition rarely missing. Referral to OPD for followup was noted.

usually available. However, the tentative nature of emergency room diagnoses in combination with the limited amount of diagnostic data, often prohibited very precise classification of the patient's illness within a diagnosis coding scheme. This led to arbitrary assignment of conditions to one category or another primarily based on achieving consistency, rather than a sound clinical rationale. Treating each symptom-diagnosis combination separately would have resulted in too many categories of illness to handle effectively in an analysis. The alternative - a greater degree of aggregation - appeared to obscure different patterns of incidence across time periods.

The classification of respiratory and related conditions illustrates the problem. The seasonal increase for all respiratory disorders was seen in Table 4. Two related categories - flu, otitis - did not show the same pattern. In Table 7 it is apparent that acute upper respiratory disease dominates the aggregate pattern of respiratory disorders, while other categories of respiratory illness again, do not have the same pattern. It must be assumed that the small frequency in several categories, and the classification scheme, have affected these distributions to some (unknown) extent.

"Flu" or "viral syndrome" is one example of the classification problem. For patients with a similar group of (recorded) symptoms the diagnosis was entered as one of these labels at times, and at other times as a respiratory disorder, and for yet other patients as a combination with respiratory diagnoses. If the complaint was G.I. upset, the diagnoses may have been flu or gastroenteritis, with the latter most often recorded for young children.

Another example of the problem is, when no specific diagnosis was entered, the question of including certain complaints or symptoms with acute upper or lower respiratory diseases. With no other indication to the contrary, symptoms such as nasal congestion and sore throat were classified with acute respiratory diseases, and pulmonary congestion and chest pain with acute lower respiratory disease. Obviously, these symptoms could have been unrelated to viral or bacterial effects on the respiratory system. On the other hand these complaints probably were more often related to respiratory infection than not, so that exclusion would have artificially lowered the rate of acute respiratory illness. It may be of interest that, in the data for Table 7, about 39 percent of the acute lower respiratory disease group consisted of symptoms without diagnosis while symptoms comprised only about 10 percent of the acute upper respiratory disease category.

For the "susceptability" classification the usual demographic parameters were recorded for almost all patients. Indicators of family or patient economic status were not available except for payment source. One of the most important parameters was considered to be categorization as to preexisting chronic disease. When the complaints were related to a chronic condition there was likely to be some indication. However, history of chronic disease was not always noted if an acute illness was diagnosed, even though the chronic condition had been recorded on prior clinic visits. This indicated that the records might not be adequate for analysis of responses in individuals with or without chronic illness.

As indicated earlier a variety of approaches to classification by "severity" were under consideration. Direct mention of severity was rarely found. Other approaches depended upon results of selected diagnostic tests, use of selected therapeutic measures that would reflect treatment intensity, or admission rate. It was found that laboratory tests were infrequently ordered for the patients of interest and the particular treatment services used in only a few cases.

Table 10 presents the frequency with which a number of data times were recorded for certain diagnostic categories. From this data two conclusions are suggested. First, diagnosis and treatment services are kept to a minimum indicated by the patient's condition and presenting complaints. These parameters would be of methodological use only if they were a consistent indicator of the more severe conditions. Use of the available data for finer degrees of severity was highly questionable. Second, if the first conclusion is correct few "severe" conditions are seen and detection of a shift in "average" severity due to oxidant effects does not appear likely.

The two other important types of data from the medical record concerned onset of symptoms and followup of the patient. Symptom onset was critical for relating the timing of high ozone levels and the development of illness. Those patients whose onset of symptom "y" was subsequent to the emergency visit must be considered as a response group separate from those who were already experiencing symptom "y." The potential success and efficiency of followup were also dependent on the accuracy, timeliness and completeness of medical record information, particularly the

Table 10. Number of Times Certain Clinical Parameters were Recorded for Selected Diagnoses (Record Abstract Sample)

Record Abstract Data Item	Emergency Room Diagnosis		
	Asthma	Chronic Respiratory Disease	Acute Lower Respiratory Disorder
Total in Sample	8	7	18
Presenting Complaints:			
Shortness of Breath	3	1	2
Disorders of Respiratory Rhythm or Sound	2	-	-
Congestion in Chest or Chest Pain	2	-	7
Vital Signs:			
Respiration Rate	7	3	7
History:			
Asthma	7	2	-
Chronic Obstructive Pulmonary Disease	1	3	-
Heart Disease	-	-	1
Diagnostic Procedures:			
Hemoglobin	-	-	1
Chest Film	-	1	7
ECG	1	1	-
Blood Gases	1	1	-
Electrolytes	-	-	-
Treatment Procedures:			
Injection	3	-	2
I.V. Fluids	-	-	-
IPPB	2	-	-
Disposition:			
Discharged	8	7	17
Admitted	-	-	1

availability of an alternate contact when there was no home telephone or the patient could not be contacted at the given home address.

Some indication of illness onset was recorded for most patients. However, this information was missing in a substantial number of cases, and in many it was not clear if the onset given pertained to all complaints or only those considered important to the primary diagnosis. Onset and followup data will be discussed further in the next section.

4.3 EVALUATION OF FOLLOWUP PROCEDURES

The followup component of the methodology was seen as essential to proper interpretation of emergency room utilization patterns. Information collected through the interview was deemed important for more precise classification of health effects and susceptability to environmental factors, and for clarification of extent and timing of pollutant exposure relative to symptom development and the emergency room visit. Certain questions were intended as supplements to the medical record abstract while others sought data that would not be provided by the medical record.

Contact with the patient by telephone was selected as the most cost-effective approach when weighed against the effort and expense associated with either emergency room or home interviews. This method had previously been used by the author for followup of emergency room patients, with mixed success. In this prior study response rate and data quality were satisfactory when contact was achieved, but the high proportion of cases for which no means of contact was readily available severely limited the value of the data collected. However, full use of information in the medical record and other potential resources (e.g., city directories) was not made, and a more extended effort may have increased success in patient contact.

For the pilot study a subset of the record abstract sample was selected from the periods February, April, June, and August 1975. This was considered sufficient to evaluate the procedures plus provide information about any change of response rate or recall with time. A common set of items to be used in tracing the patient was abstracted for the interviewer. She then reviewed the record for any additional information if the initial set proved insufficient.

A total of 88 interviews by telephone were attempted. Interview completion by month of visit is shown in Table 11. For patients who had been seen within the past month or so prior to the attempt the completion rate was considered excellent for a telephone survey (77.3 percent). This rate dropped off sharply for the earlier months, generally because patient mobility prevented contact. Given that a respondent was reached, the rate of interview refusal was low.

Table 11. Completion of Interviews by Month of Emergency Room Visit

Interview Completion		Month of E.R. Visit				Total
		Feb	Apr	Jun	Aug	
Completed	#	12	10	11	17	50
	%	48.0	50.0	52.4	77.3	56.8
Refused	#	3	1	1	0	5
	%	12.0	5.0	4.8	0.0	5.7
Not Contacted	#	10	9	9	5	33
	%	40.0	45.0	42.9	22.7	37.5
Total	#	25	20	21	22	88
	%	100.0	100.0	100.0	100.0	100.0

Completion rate associated with patient ethnic group and age is seen in Table 12 and 13. Ethnic bias did not seem an important factor. The response rate was lower than average in the group 18-44 years which made up the largest number of patients and which probably were the most mobile.

Table 12. Interview Completion by Ethnic Group

Interview Completion		Ethnic Group					Total
		Unknown	White	Black	Mexican	Indian	
Completed	#	0	32	8	9	1	50
	%	0.0	54.2	72.7	56.3	100.0	56.8
Refused	#	0	1	2	2	0	5
	%	0.0	1.7	18.2	12.5	0.0	5.7
Not Contacted	#	1	26	1	5	0	33
	%	100.0	44.1	9.1	31.3	0.0	37.5
Total	#	1	59	11	16	1	88
	%	100.0	100.0	100.0	100.0	100.0	100.0

Table 13. Interview Completion by Age of Patient

Interview Completion		Age of Patient (Completed Years)					Total
		Under 5	6-17	18-44	45-64	65 Plus	
Completed	#	4	7	22	10	7	50
	%	66.7	87.5	48.9	66.7	50.0	56.8
Refused	#	1	0	1	1	2	5
	%	16.7	0.0	2.2	6.7	14.3	5.7
Not Contacted	#	1	1	22	4	5	33
	%	16.7	12.5	48.9	26.7	35.7	37.5
Total	#	6	8	45	15	14	88
	%	100.0	100.0	100.0	100.0	100.0	100.0

Table 14 reflects the effort of the interviewer in reaching a respondent. The number of calls include all those made to locate the patient, as well as to contact the patient's residence. Besides clues from the medical record, a "criss-cross" directory was used to identify neighbors through whom the patient might be contacted, if no telephone was found. Few calls were needed to obtain completed interviews.

Table 14. Interview Completion by Number of Telephone Calls Made

Interview Completion		Number of Calls								Total
		1	2	3	4	5	6	7	8+	
Completed	#	20	13	10	3	1	2	1	0	50
	%	40.0	26.0	20.0	6.0	2.0	4.0	2.0	0.0	100.0
Refused	#	2	1	1	0	1	0	0	0	5
	%	40.0	20.0	20.0	0.0	20.0	0.0	0.0	0.0	100.0
Not Contacted	#	6	9	5	6	2	2	0	3	33
	%	18.2	27.3	15.2	18.2	6.1	6.1	0.0	9.1	100.0
Total	#	28	23	16	9	4	4	1	3	88
	%	31.8	26.1	18.2	10.2	4.5	4.5	1.1	3.4	100.0

Other aspects of the interviewing are presented in Tables 15 and 16. Ninety-six percent of the interviews were completed on calls of 20 minutes or less. For the bulk of the completed interviews either the patient or a close relative was available.

Table 15. Time for Interview (Completed Interviews)

	Interview Time (Minutes)					Total
	1-5	6-10	11-15	16-20	Over 20	
Completed Interviews						
#	2	24	18	4	2	50
%	4.0	48.0	36.0	8.0	4.0	100.0

Table 16. Respondent for Completed Interviews

	Respondent			Total
	Patient	Mother or Spouse	Other	
Completed Interviews				
#	29	13	8	50
%	58.0	26.0	16.0	100.0

If attempted within 30 days or less of the patient visit it appeared that the completion rate for the interviews would be satisfactory, even among the most mobile group of patients. This indicated that interviewing must be continuous over the period of study. There was also the question of accurate recall if the lag time was extensive.

Comparison of complaints and onset entered in the medical record with those reported on interview provided an opportunity both to evaluate this data and to gain some insight into recall. In Table 17 a comparison is made between reported and recorded symptoms for patients with respiratory conditions. Included are all those with these diagnoses, plus others who reported respiratory complaints but no respiratory system diagnosis was made. In the interview the patient (or other respondent) was asked to recall the complaints and the onset of the earliest symptom in terms of time prior to the E.R. visit.

Table 17. Comparison of Complaints and Duration of Symptoms from Patient Interview with Those from E.R. Record: Respiratory Conditions

Case Number	Age	Interview	Record Abstract	
1	23y	Sore Throat (>7d) Cold	Sore Throat (?) Cough (?) Discharge from Eye (?)	August
2	29y	Pain in Lower Extremity (>7d) Pain in Upper Extremity	Cold (?) Weakness of Extremities (?) Pain in Chest (?)	August
3	30y	Pain in Back (hrs) Dizziness	Cough (6d) Earache (6d)	August
4	6m	Nasal Congestion (2-3d)	Nasal Congestion (3d)	August
5	20y	Shortness of Breath (hrs)	Headache (3h) Nausea (3h) Shortness of Breath (3h)	August
6	60y	Shortness of Breath (>7d) Cough Fever	Shortness of Breath (7d) Cough (7d)	August
7	33y	Shortness of Breath (>7d) Congestion in Chest	Abdominal Pain (12h) Shortness of Breath (12h)	June
8	53y	Shortness of Breath (3-7d) Urine Abnormal	Shortness of Breath (3d) Fluid Imbalance (3d) Phlegm (3d) Pain in Chest (3d)	June
9	11y	Abnormal Respiration (hrs)	Shortness of Breath (?) Abnormal Respiration (?)	June
10	6y	Fever (hrs) Sore Throat	Fever (2d) Sore Throat (2d) Cough (2d)	June
11	30y	Pain in Chest (2-3d)	Cold (14d) Cough (14d) Fever (?) Pain in Chest (2d)	April
12	25y	Pain in Chest (3-7d)	Pain in Back (3d) Abdominal Pain (3d) Pain in Chest (3d) Shortness of Breath (3d) Cough (3d)	April
13	47y	Fainting (2-3d) Pain in Chest	Shortness of Breath (?) Muscle Ache (?) Nasal Congestion (?)	April
14	29y	Shortness of Breath (1d) Chills Nervousness	Behavioral Distrubance (3d)	February
15	18y	Cold (1d) Headache	Sore Throat (?)	February
16	11y	Earache (1d) Discharge from Ear	Earache (2d) Fever (2d) Cold (7d)	February
17	73y	Cold (3-7d) High Blood Pressure	Cough (14d) Nasal Congestion (?)	February
18	19y	Abnormal Respiration (1d)	Cough (?) Sore Throat (?) Nasal Congestion (?)	February
19	3y	Fever (2-3d) Cold	Nasal Congestion (7d) Earache (1d) Chills (?)	February
20	4y	Rectal Symptoms (2-3d)	Sore Throat (?) Cough (?)	February

Summary:

	Some Agreement		No Agreement		Unknown	
Month	Symptoms	Duration	Symptoms	Duration	Duration	Total Patients
August	5	3	1	1	2	6
June	4	1	-	2	1	4
April	2	2	1	-	1	3
February	4	-	3	4	3	7
Total	15	6	5	7	7	20

All patients listed in Table 17 who were 18 years of age or older were interviewed directly, while a proxy respondent (usually the mother) furnished the information for those under 18 years of age. Only slight editorial changes were made in the reported or recorded symptoms shown. The numbers in parentheses are durations in hours (h) or days (d). A question mark indicates that duration was not recorded for that particular complaint and it is not clear if the time for other symptoms is applicable.

Correspondence between reported and recorded data is summarized at the bottom of Table 17. There was some agreement for symptoms in 75 percent of these cases, the percentage seemingly decreasing with time elapsed since the patient was seen. Substantially less correspondence was shown for duration but this was affected by the lack of recorded duration for 35 percent of the cases. It may be noted that Case 14 would not have been identified as "respiratory" from the record or Cases 2, 3, and 20 from the interview.

The importance of eliciting all symptoms and their onset has been stressed. From this brief analysis it appears that the interview can provide useful information on these items if the patient is contacted soon after the visit. A better strategy perhaps would be promotion of more complete recording by the attending providers during the period of study.

The discussion thus far has concerned the overall utility of a followup interview. In the tables that follow, distributions of patients according to responses on interview are presented. Because of the small sample these data are intended as illustrative only.

Tables 18 and 19 provide examples of the use of functional status scales. Table 18 indicates the frequency of chronic limitations among activity categories. The latter categories are associated with behavior patterns relevant to exposure and use of health facilities. For example 56 percent (11 + 17) are exposed mostly to ambient levels in the area of their residence and of these more than half (15) have chronic limitation from disease or injury. Such data may be used for comparisons of patient populations among different emergency rooms. In Table 19, the change in functional status due to the illness is indicated, adjusted for usual limitation but not for activity category. Shifts in these proportions over time for the same population of users may indicate degree of impact of etiological agents. Comparisons among populations could show differential response to the same insult. A fairly high percentage did not recall if their illness caused any change in functional level.

The remaining tables concern various factors that may be associated with the extent of exposure to pollutants. Tables 20 and 21 show proportions that remained indoors most of the time prior to the first symptom and that spent at least two continuous hours outside shelter. Tables 22 through 26 consider exposure of employed persons and illustrate the following points:

Table 22 - Persons who leave the area for which ambient concentrations are measured ("Metro" area)

Table 18. Usual Activity by Presense of Activity Limitation (Completed Interviews)

Usual Activity		Limitation in Amount or Kind of Activity			Total
		Unknown	No Limitation	Chronic Limitation	
Employed	#	1	11	2	14
	%	7.1	78.6	14.3	100.0
Housewife	#	0	5	6	11
	%	0.0	45.5	54.5	100.0
Student	#	1	6	1	8
	%	12.5	75.0	12.5	100.0
Remain at Home	#	0	8	9	17
	%	0.0	47.1	52.9	100.0
Total	#	2	30	18	50
	%	4.0	60.0	36.0	100.0

Table 19. Degree of Activity Limitation Associated With Reported Respiratory Conditions (Completed Interviews)

Degree of Limitation		Reported Respiratory Conditions			Total
		Upper Respiratory	Lower Respiratory	Both	
Unknown	#	2	3	1	6
	%	15.4	37.5	50.0	26.1
Normal Activity	#	4	0	0	4
	%	30.8	0.0	0.0	17.4
Reduced Activity	#	1	2	0	3
	%	7.7	25.0	0.0	13.0
In Bed	#	6	3	1	10
	%	46.2	37.5	50.0	43.5
Total	#	13	8	2	23
	%	100.0	100.0	100.0	100.0

Table 20. Outdoor Exposure Prior to Symptom Onset, for Patients Reporting Respiratory Symptoms (Completed Interviews)

Outdoor Exposure		Reported Respiratory Symptoms Upper Respiratory	 Lower Respiratory	 Both	Total
Unknown	#	1	0	0	1
	%	7.7	0.0	0.0	4.3
Remained Inside	#	11	6	2	19
	%	84.6	75.0	100.0	82.6
Outdoors >2 Hours	#	1	2	0	3
	%	7.7	25.0	0.0	13.0
Total	#	13	8	2	23
	%	100.0	100.0	100.0	100.0

Table 21. Outside Exposure Prior to Symptom Onset, Patients With/Without Chronic Limitation (Completed Interviews)

		Limitation in Amount or Kind of Physical Activities Unknown	 No Limitation	 Chronic Limitation	Total
Unknown	#	1	1	2	4
	%	50.0	3.3	11.1	8.0
Remained Inside	#	1	23	12	36
	%	50.0	76.7	66.7	72.0
Outdoors >2 Hours	#	0	6	4	10
	%	0.0	20.0	22.2	20.0
Total	#	2	30	18	50
	%	100.0	100.0	100.0	100.0

Table 22. Place of Work for Employed Patients (Completed Interviews)

	Place of Work			Total
	Unknown	Metro Area	Other Area	
Completed Interviews				
#	1	10	3	14
%	7.1	71.4	21.4	100.0

Table 23. Time of Day for Work, Employed Patients (Completed Interviews)

	Time of Day			Total
	Unknown	Day	Night	
Completed Interviews				
#	1	12	1	14
%	7.1	85.7	7.1	100.0

Table 24. Usual Work Site, Employed Patients (Completed Interviews)

	Usual Work Site				Total
	Unknown	Inside	Outdoors	Combination	
Completed Interviews #	1	7	2	4	14
%	7.1	50.0	14.3	28.6	100.0

Table 23 - Persons who are subject to peak residential area concentrations rather than those in the area of their workplace

Table 24 - Persons exposed to ambient levels to a greater extent

Table 25 - Persons exposed to pollutant levels along commuting routes for varying lengths of time

Table 26 - Persons exposed to additional stress or pollutants.

Some of these items were also obtained for school children. Respondents were also asked if school, office, and home were air conditioned.

The tables derived from interview data show some of the information that might be obtained and how it might be used in specifying subgroups for analysis.

Table 25. Round Trip Commuting Time, Employed Patients (Completed Interviews)

	Commuting Time				Total
	Unknown	Under 30 min.	30-60 min.	1-2 hours	
Completed Interviews #	1	6	5	2	14
%	7.1	42.9	35.7	14.3	100.0

Table 26. Extreme Exposure Conditions in Occupational Environment, Employed Patients (Completed Interviews)

	Occupational Environment				Total
	Unknown	None	Temperature Extreme	Pollution Exposure	
Completed Interviews #	1	9	1	3	14
%	7.1	64.3	7.1	21.4	100.0

Section 5.0

SUMMARY AND CONCLUSIONS

Ozone, a powerful oxidant, is the major component of the so-called photochemical oxidant pollutant complex. Extensive animal experiments have explored both pulmonary and extrapulmonary pathology from ozone inhalation. Chamber studies with human volunteers, such as those of Hackney et al., have documented marked acute respiratory responses to ozone concentrations comparable to ambient levels experienced in some U.S. metropolitan areas. The latter studies also found substantial differences in human sensitivity to ozone exposure.

A review of the literature has identified few epidemiological investigations of ozone effects. These studies have reported statistical associations of ambient levels with respiratory symptoms among nursing students, with impaired performance of student athletes, with increased attacks in a small proportion of asthma patients, and with hospital admissions. In contrast, no significant relationship between oxidant levels and school absenteesim due to respiratory illness was found. Epidemiological research on the effects of long-term exposure in humans was not identified.

Toxicological evidence indicates that ozone acts through a variety of pathological mechanisms, and thus sufficient exposure may be hypothesized to result in a variety of responses. These might range from minor throat inflammation, to increased susceptability to respiratory infections, to exerbation of chronic conditions (respiratory and nonrespiratory) depending on individual dose, duration, and sensitivity. The available epidemiological studies lend some support to this hypothesis.

This report has described an approach to study of the variety of potential responses to high ambient ozone concentrations: correlation of changes in emergency room utilization patterns with estimated levels of exposure. The initial version of methodology for collection and classification of pertinent epidemiological data has been developed. Emphasis in design has been placed on achieving a high degree of specificity in categorizing health status, pollutant exposure and facility utilization patterns. A brief pilot trial has been conducted to test the procedures and to examine the general utility of the technical plan.

In reviewing results from the pilot study a number of problem areas were highlighted:

1. Differences in utilization patterns among the groups seeking care at the facility that complicate their relationship with community incidence of illness.
2. Difficulty in categorization of presenting health problems in a manner which would achieve both pertinent representation of incidence and adequate sample size.
3. Insufficient clinical data to support resolution of diagnostic category and grading severity.
4. Number of potentially important subclassifications of patients that may require separate attention in the analysis.
5. Difficulty in establishing the timing of symptoms relative to ozone exposure levels.

On the positive side, the methods of data collection met the expected efficiency. At least in the target community a good followup rate was achieved if initiated soon after the emergency room visit. Most of the interview questions appeared to meet their objective in establishing the individual patient's situation.

Many of the technical problems discussed are not unique to this approach. Appropriate specification of symptoms and timing, the interferrence of exogenous factors, and the large number of variables are inherent difficulties in any epidemiological study of ambient pollutant impact. However, adequate application of the proposed approach would seem to require specialized data collection on a prospective basis. Also, to obtain the patient population needed to detect ozone effects (or to establish the hypothesis of "no effect") a number of area facilities must be included in the study.

The modifications suggested would substantially increase the costs of study, reducing this advantage over other approaches. They would also require a great deal of cooperation from the facilities included. Most important, though, each facility included would increase the problems in interpretating utilization patterns. That is, one cannot assume that the populations from each facility can be combined in a simple, additive manner until it is established that the basic utilization patterns are indeed comparable. Variation in the characteristics of the facilities and area residents would make this unlikely. Thus each facility and area would require separate study before any aggregation was attempted.

The pilot study does not pretend to be a full and comprehensive test of this general approach to research on pollutant effects, or of the particular methodology developed. That is, we cannot justify either the acceptance or rejection of using emergency room patient populations.

Further, the methodology is not complete in terms of effects measures and analytical models. And, we have not yet attempted any linkage of ambient ozone concentrations and illness patterns.

The evaluation to this point has provided guidance as to:

- Revisions which may improve specificity, i.e., prospective study with specialized data collection by the emergency room
- Need for expansion of the scope of facilities in the Riverside area to provide sufficient sample size
- Certain problems relating to the interpretation of emergency room utilization patterns.

From a conservative view these findings do not support the assumptions of adequate effectiveness and low cost that were important components of the proposed approach. It appears that no aspect has emerged which would reduce the expected high risk in producing valid and reliable exposure-effect determinations within a relatively uncontrolled design. Indeed, the pilot study results have reinforced that risk. We must conclude then that the utility of the proposed approach for definitive study of ambient oxidant effects on human health is highly questionable.

Section 6.0

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PART II - METHODOLOGY FOR MAPPING OF AMBIENT OZONE CONCENTRATIONS*

Section 1.0

INTRODUCTION

The purpose of this study was to investigate and map the temporal and geographical distributions of ozone concentrations in the metropolitan Riverside area so that daily exposures might be calculated for estimating the effect of short-term exposure to indicated emergency levels of ozone on human morbidity. In the course of this study the possibility for a similar but more extensive investigation was examined; such a future study would involve a larger geographical area (i.e., the total eastern section of the Los Angeles basin) and would necessitate the formulation of a dense grid of ozone estimation-points from a larger number of monitoring stations than the number involved in the initial development.

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* Written by Demetrios J. Moschandreas, Ph.D.

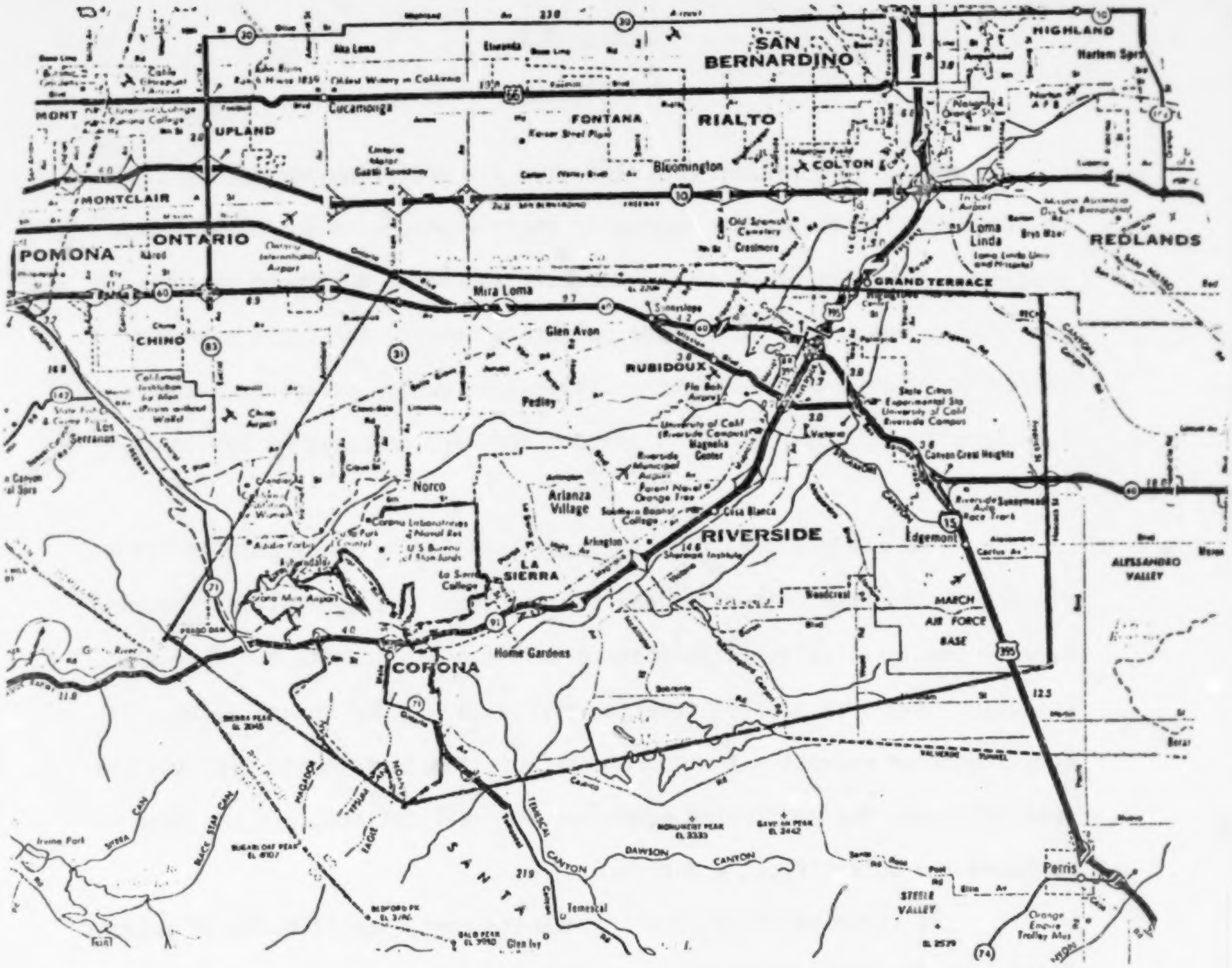
Section 2.0

THE PROBLEM

Many communities have conducted air pollution monitoring studies to determine the nature and degree of their exposure to pollutant concentrations. Few have utilized a systematic approach. Although the aim of the studies was to define average pollution levels, the small number of monitoring stations included were situated on public buildings rather than in scientifically chosen locations and were operated on unscientific schedules.

The subject area of this study (see Figure 1) is both an illustration of the usual situation and an exception. It exemplifies the rule because the local authorities operate only two stations to estimate the pollution levels of an area covering approximately 300 square miles. It constitutes an exception to the rule because the instruments used are the most advanced, the monitoring schedules are well defined, and the data gathered are scientifically analyzed.

The problem of pollutant concentrations, specifically of oxidant levels, in the Los Angeles basin has been studied by many researchers, owing to the persistence of high levels of ozone densities. The approach described in this document is, however, unique because it did not seek to estimate the pollutant source strength, the rates of the various depletion mechanisms or the chemical kinetic schemes; it utilizes only ozone concentration pollution readings and meteorological data from the two monitoring stations in the Riverside zone of the Southern California Air Pollution Control District (APCD).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Harlem Spr
Alta Loma
Etiwanda
Cucamonga
UPLAND
FONTANA
RIALTO
Bloomington
COLTON
MONTCLAIR
POMONA
ONTARIO
Loma Linda
REDLANDS
GRAND TERRACE
Mira Loma
Glen Avon
CHINO
RUBIDOUX
Pedley
Los Serranos
Norco
Arlanza Village
Casa Blanca
RIVERSIDE
Edgemont
ALESSANDRO VALLEY
LA SIERRA
Woodcrest
MARCH AIR FORCE BASE
Home Gardens
CORONA
SANTA
TEMESCAL CANYON
DAWSON CANYON
Temescal
Glen Ivy
STEELE VALLEY
Perris
University of Calif Riverside Campus
Canyon Crest Heights
Riverside Municipal Airport
Ontario International Airport
La Sierra College
PRADO DAM
Old Spanish Cemetery
Crestmore
Sunnyslope
State Citrus Experimental Sta University of Calif Riverside Campus
Irvine Park

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Figure 1. The Riverside Metropolitan Area

Almost all the relevant studies on ozone levels have focused on the average behavior or on the daily variation of O_3 for a short period of time. The present study took a different approach; it examined the pollutant behavior on a daily basis for the duration of the five-month high ozone period of the year. The necessity for a day-by-day study will become apparent later in this document. For the present, it suffices to point out that the investigation of the average ozone level concentrations neglects the variations within the ozone cycle and the in-depth study of a short time interval (e.g., two weeks) is not representative of the total ozone summer period.

Constraints imposed by the funding and time limitations of the overall study made a phenomenological approach to the problem the only viable alternative. That [illegible]. while we did not formulate or utilize existing complex photochemical simulation models we also did not simply use arbitrary methods of extrapolation between stations. The approach here used pertinent data, incorporated available theories, validated (to the extent possible) methods and ideas presented, enumerated the available options and explained the choice made.

It must be pointed out that in spite of the continuous, serious, and complex research on the subject of photochemical smog generation and transport, there does not exist a universally accepted theory and none seems to be forthcoming in the near future. EPA has recently recognized the difficulties involved in the formulation of an overall theory explaining the complex situation and has acknowledged the necessity for an empirical study.*

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* Request for Proposal WA 75-R310, on "Simple Algorithms for Determining the Effect of VTM Reduction on Oxidant Concentrations."

It appears that our approach follows the EPA guidelines. The Agency, while not ignoring the importance of formulating a comprehensive photochemical simulation model, is also searching for a practical procedure for estimating ozone concentrations from the data of the existing monitoring networks. The problem, therefore, was to formulate an empirical model which estimates the ambient ozone concentrations in the Riverside metropolitan area by mapping in time and space the hourly pollutant concentration data obtained from the two monitoring stations located within the subject area.

Section 3.0

DISCUSSION OF OPTIONS, CHOICE, AND REASONS

In studies of photochemical smog generation, diffusion, and advection, it is often assumed that concentrations of ozone are uniform over square areas with sides of 40 km or larger centered over a given monitoring station[6,9] or, for oxidant trend investigations, one average concentration representing the total area of a large city is often obtained.[1] The metropolitan Riverside area is smaller than the equivalent area side of 40 km and obviously smaller than the area of large cities in Altshuller's work. Two monitoring stations, the Riverside station and the Corona station are operated by the Southern California Air Pollution Control District - Riverside Zone; the distance between the two stations is 20 km. Even though the area is small, the distance between the monitoring stations is appropriate for averaging and the difference in O_3 concentrations is within the limits of other studies, we could not assume one representative concentration over the diurnal cycle. The California State Air Resources Board operates a third station, the Magnolia monitoring station, within the subject area. Data from this station were obtained late in the development of this project; thus, the Magnolia data were used to "validate" the approach and "extend" the initial procedure.

The study of the air pollution data, the requirements of the health study, and the indications of the meteorological data analysis have led to divisions with respect to geography, ozone concentrations, and time intervals.

3.1 TIME PERIODS

The present study investigated four months and includes plans to incorporate two more months which would encompass the summer ozone cycle. Table 1 shows the days and hours with large O_3 concentrations and their monthly variations. The illustrated range necessitates a month-by-month study. The desire to estimate the daily exposure of an individual to ozone concentration necessitated a more refined time interval: the daily cycle. Further studies of the ozone concentrations indicated another time subdivision: the "day" hours, 0900-2000 inclusive, during which all the structure of ozone variation appears, and the "night" hours, 2100-2300 and 0000 to 0800 inclusive, which possess only a background ozone concentration. During the "day" hours the hourly variations were examined, while during the "night" hours only one representative monthly background ozone concentration was calculated.

3.2 OZONE CONCENTRATIONS

It was assumed that a variation of at least 0.1 ppm of O_3 was necessary in order to define the effect, if any, of short-term exposure of ozone on human morbidity. A 0.1 ppm O_3 concentration (one-hour average) is the lower limit for an ozone event to be called by the local authorities in the Southern California APCD and, therefore, multiples of this concentration seemed appropriate for use in epidemiological studies.

Type I Days

If during the "day" hours there was no hourly concentration reading higher than 10 pphm for both stations, we estimated one representative value for the subject area and for the total time period

Table 1. Total Days and Hours >.20* ppm of O_x, 1975-1970, for Riverside

Month	1975		1974		1973		1972		1971		1970	
	Days	Hours	Days	Hours	Days	Hours	Days	Hours	Days	Hours	Days	Hours
Jan.	0	0	0	0	0	0	0	0	0	0	0	0
Feb.	0	0	0	0	0	0	0	0	0	0	0	0
Mar.	1	1	2	4	0	0	2	3	3	8	0	0
Apr.	0	0	0	0	3	5	0	0	0	0	1	2
May	8	21	3	6	5	9	0	0	1	1	4	9
June	10	21	15	56	13	33	8	31	7	13	10	31
July			12	30	11	32	19	64	10	27	20	78
Aug.			17	42	8	20	7	14	11	22	19	61
Sept.			15	30	2	5	9	21	11	29	10	35
Oct.			2	3	4	7	0	0	4	9	5	9
Nov.			0	0	1	1	0	0	0	0	1	2
Dec.			0	0	0	0	0	0	0	0	0	0
Total	18	48	66	171	47	117	45	133	47	101	70	227

*Absolute Value (Corrected using .8 Factor)

Note: $[O_3]$ >.20 ppm is chosen because this is the level at which the local authorities call the first stage of an 030 alarm.

Source: Air Pollution Control District (APCD) - Riverside Zone covered by "day" hours. These days were designated Type I days and the representative value was the mean of all the hourly concentrations from both stations during each such day.

Type II Days

If at least one hourly O_3 concentration was larger than or equal to 10 pphm and if the difference of the hourly ozone concentrations between the two stations was less than ± 5 pphm, then we estimated 12 hourly ozone concentrations for the subject area. These days were Type II days and each of the hourly values was the mean of the respective hourly readings from Corona and Riverside.

Type III Days

If at least one hourly $[O_3]$ is greater than or equal to 10 pphm and the difference between the two stations for at least one hour was equal to or larger than 5 pphm, then two geographic zones were defined and one representative hourly concentration per zone was estimated. These days were called Type III days. The value for each zone is explained in detail in Section 4.0.

3.3 GEOGRAPHIC ZONES

A division with respect to geographic areas was a more difficult undertaking than the generation of the previous two classifications. The options are easily defined: one geographic area combining the data from both stations, two geographic zones including the areas surrounding the monitoring stations, and finally a larger number of grid points generated by extrapolation or interpolation of the existing points or by the formulation of a complex model. The first option was easily rejected because during the period investigated there were readings that did not conform to one number. It was often observed that one of the stations is continuously represented by the lower limit and the other then, the upper limit. Thus either individual reading would misrepresent the other area. Another reason for rejecting the first choice was that ozone concentration readings at one of the stations were often due to local production while readings at the other encompassed ozone levels due to advection. Most importantly, there were days when two advection mechanisms were operating. The third option was rejected because there were only two monitoring stations; more are required to validate the model that would be essential for the generation of a denser network. Also, the small distances involved would necessitate an extremely complex model clearly beyond the scope of this work. The definition of concentrations for each of the two geographic zones, the second option, is not easy and involves three signature parameters: (1) the definition of the advection mechanisms involved in the transport of O_3 from the Los Angeles and Orange County areas; (2) the boundaries of the investigated area and its topographic features; and (3) the existence of validating data from neighboring stations, literature articles and some routine statistical indications to confirm the final choice.

In a study on oxidant distribution and analysis in the San Bernardino basin, Zeldin (1973) defined the "advection number" $A \equiv H - F$. This concept helps in ascertaining areas which appear to be more susceptible to advection than to local area pollution. In the definition of the advection index, H is the total number of hours in a given day between the first and the last occurrence of at least a 0.10 ppm ozone concentration value. The value of this parameter goes beyond the definition of the advective index because it denotes the total number of hours per day with a high ozone concentration, a factor that may directly affect the relationship between ozone levels and human morbidity. Returning to the explanation of the symbols in the advective index equation, F denotes the hour of the day, based on a 24-hour clock, in which a reading of 0.10 ppm or more was first recorded. The importance of the advective index, or advection number, and its implications were clearly stated by Zeldin:

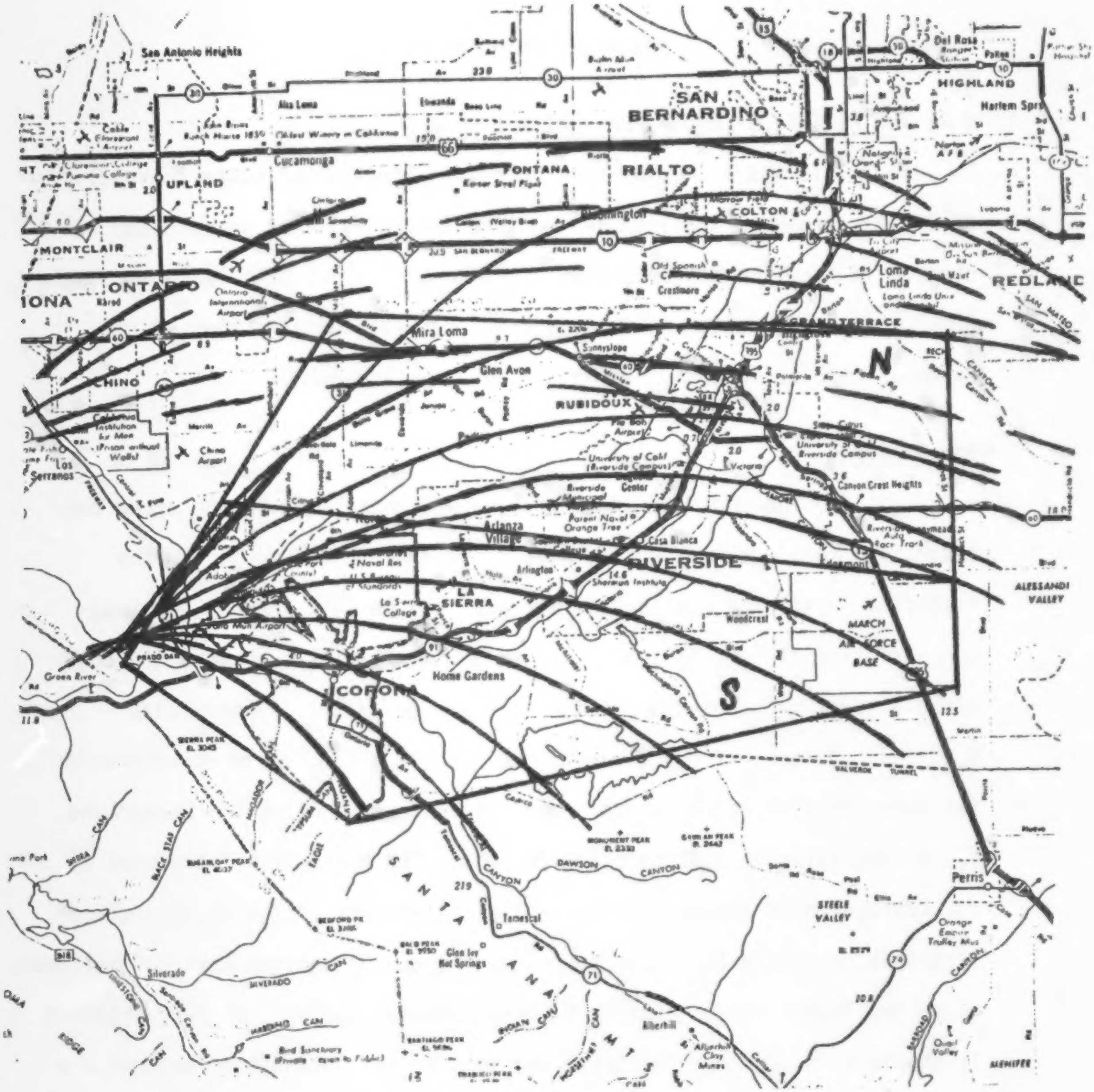
> "A location, influenced by already existing or locally emitted pollutants, tends to start reacting photochemically (in the summertime) shortly after sunrise. Thus, a value of 0.10 ppm might be reached early in the day (approximately 9:00 a.m.), gradually increase to a peak in the afternoon, and then gradually subside to a value below 0.10 ppm (approximately 6:00 p.m.). Using this example, the advection number A, equals 10 (hours above 0.10 ppm) minus 9 (o'clock) or a +1.
>
> "A site more influenced by advection generally exhibits a later rise to the 0.10 ppm value (approximately 12 noon) but a more pronounced afternoon peak as the advected mass is carried over the site. By the same token, the decrease is more pronounced with the oxidant value falling below the 0.10 ppm level late in the afternoon (approximately 5:00 p.m.). Under this condition, the advection number would equal 6 (hours above 0.10 ppm) minus 12 (o'clock) or a -6. Therefore, the more negative the advection number, the more likely advective processes were at work. Conversely, the more positive the advection number, the greater the influence from either local or pre-existing precursors. The advection number thus represents a numerical means of expressing a characteristic oxidant trace."

The advection index was utilized in this document to indicate the days of advective influence, as opposed to local generation. Studies by

Hanna[6], Zeldin[2], E.E. Anderson[2], and Arnold[3] indicated two sets of wind flows which might influence the advective mechanism that carries the ozone cloud from the Los Angeles area to the eastern segment of the L.A. basin. The first one is the wind flow pattern through the Carbon Canyon which mostly influences the San Bernardino County. The second one is the wind flow pattern through the Santa Ana Canyon which may be divided in two branches - the northern one induces an advection mechanism over the northern segment of Riverside County, including the Riverside monitoring station and the Redlands station of the San Bernardino County monitoring network. This flow pattern may interact with the Carbon Canyon southern branch pattern and thus generate streamlines that would relate the ozone diurnal distribution along an axis connecting Chino-Riverside and Redlands; such a connection has been observed. The other branch related to the Santa Ana Canyon wind flow pattern follows the topography to the southern segment of the Riverside County and relates ozone concentrations of the Santa Ana, Orange County, and Corona monitoring stations. These patterns, when present, divide the subject area in two zones, the southern and northern zones, see Figure 2, and were verified, to the extent possible, in the month-by-month analysis of the available data.

It is evident that the approach taken does not consider specific sources or sinks of ozone generation or depletion, and it does not involve simulation procedures; it generates a geographical grid based upon the needs of the present study, not the ozone concentration gradients calculated from readings obtained from the existing local monitoring network.

Throughout this document a basic assumption was made: the horizontal diffusion was considered negligible. This has been shown to be true in urban regions[5,8]; thus the assumption made was that the advected ozone cloud is transported strictly through urban regions.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Ontario International Airport
IONA
Loma Linda
REDLANDS
Crestmore
GRAND TERRACE
Mira Loma
Glen Avon
Sunnyslope
CHINO
RUBIDOUX
N
Chino Airport
Los Serranos
University of Calif (Riverside Campus)
Riverside Municipal
Canyon Crest Heights
Arlanza Village
Casa Blanca
RIVERSIDE
Arlington
LA SIERRA
La Sierra College
Woodcrest
MARCH AIR FORCE BASE
ALESSANDRO VALLEY
PRADO DAM
Green River
Home Gardens
CORONA
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SIERRA PEAK
DAWSON CANYON
Perris
STEELE VALLEY
SANTA ANA MTS
Tenescal
Glen Ivy Hot Springs
Silverado
Alberhill
Quail Valley
MENIFEE

Figure 2. The Metropolitan Riverside Area, the Two Geographic Zones and the Wind Flow Pattern from the Santa Ana Canyon. It must be emphasized that the wind streamline pattern and the two segment division indicated is only an estimation of the persistent wind patterns.

Section 4.0

MONTH-BY-MONTH ANALYSIS

4.1 THE RIVERSIDE-CORONA MONITORING STATIONS

This was a step-by-step process. The diurnal ozone concentration analysis was always analyzed in two time intervals, that is each day was divided in "day" hours (0900-2000), and "night" hours (2100-2300 and 0000-0800). The first step was to define the representative number which expresses the background, "night" hours, concentration.

April 1975

For the month of April 1975, the Corona "night" hour ozone concentration readings have an arithmetic average of 1.06 pphm, for the Riverside monitoring station the average is 1.59 pphm and the combined concentration average is 1.32. It was arbitrarily assumed that the combined average plus one-half of the standard deviation, in this case 1.21/2 = 0.60 pphm of O_3, would denote the background ozone concentration for every day during the month under consideration. Thus the background O_3 concentration is 1.92 pphm $\cong$ 2.00 pphm. The correction introduced to the average value along with the explicit statement of the concentration distribution during the night hours (see Figure 3) denotes what was believed to be the "best" representative O_3 concentration during this time interval. It should be noted that the great majority of the background readings are very close to the instrument sensitivity, 0.01 ppm[3], and should be viewed under this constraint. The addition to the arithmetic mean of the correction term defines a background concentration which is not on the noise level of the instruments utilized.

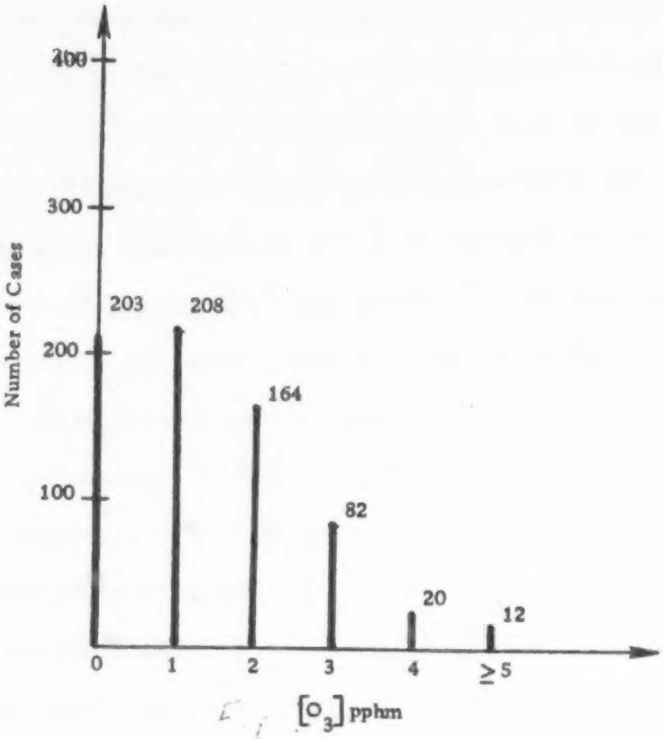

Figure 3. Distribution of Ozone Concentration for the "Night" Hours During the Month of April 1975

Since the demarcation line for the two stations in the subject area was set at 10 pphm, we next attempted to find out the number of days and the number of hours for Type III days during the month of April. Table 2 indicates only three such days.

Table 2. Ozone Concentration Difference Between Corona and Riverside for Days with Difference ≥ 5 pphm; April 1975

```
DAY= 20 HOUR= 12 CORONA CONC= 15 RIVERSIDE CONC=  8 DIFF=  7
DAY= 20 HOUR= 13 CORONA CONC= 19 RIVERSIDE CONC=  9 DIFF= 10
DAY= 20 HOUR= 19 CORONA CONC= 14 RIVERSIDE CONC=  7 DIFF=  7
DAY= 20 HOUR= 20 CORONA CONC=  9 RIVERSIDE CONC=  4 DIFF=  5
DAY= 29 HOUR= 10 CORONA CONC= 10 RIVERSIDE CONC=  4 DIFF=  6
DAY= 29 HOUR= 11 CORONA CONC= 11 RIVERSIDE CONC=  5 DIFF=  6
DAY= 29 HOUR= 13 CORONA CONC= 17 RIVERSIDE CONC= 12 DIFF=  5
DAY= 30 HOUR= 10 CORONA CONC=  7 RIVERSIDE CONC= 13 DIFF= -6
```

The advective index table, Table 3, indicates not only the various parameters entering into its definition but it also denotes all the days that had at least one hourly ozone concentration of 10 pphm or more; these days also necessitate further investigation because they show structure in the diurnal variation of the ozone concentration. It is observed that four days in Corona and five days in Riverside have a maximum concentration of at least 10 pphm; since two of these days do not coincide a total of six days need further investigation. These days fall within the limit of ozone concentration difference less than 5 pphm; therefore they are Type II days and require hourly structure. Before this option is taken, a final check is necessary to avoid the possibility of one of the stations continuously being the lower limit and the other the upper limit; Table 4 illustrates this procedure. Note that the ozone concentration difference is taken respectively for each hour during the day hours of the diurnal ozone variation for the two pertinent stations. The table shows quite a symmetric distribution for the different readings, it is, therefore, concluded that for the Type II days, one hourly ozone concentration is a representative number for the metropolitan Riverside area.

For the three Type III days shown in Table 2 we need to define two geographic zones. To do so we check the advective index, the hourly variations for the days, the wind roses of the stations under investigation as well as other relevant stations and we call for support of our conclusions from the literature. We shall explicitly show the details when we investigate the month of May which has more than three days in

Table 3. The Advection Number for Corona and Riverside for the Month of April 1975

STAT	DATE	F	MAX CONC	TIME MAX	H	A
CO	750401	0	7	14	1	1
CO	750402	0	9	17	1	1
CO	750403	0	7	10	1	1
CO	750404	0	4	12	1	1
CO	750405	0	3	9	1	1
CO	750406	0	4	12	1	1
CO	750407	0	5	12	1	1
CO	750408	0	2	9	1	1
CO	750409	0	5	15	1	1
CO	750410	0	5	10	1	1
CO	750411	0	5	12	1	1
CO	750412	0	9	13	1	1
CO	750413	0	8	12	1	1
CO	750414	0	5	0	1	1
CO	750415	0	3	8	1	1
CO	750416	0	6	13	1	1
CO	750417	0	5	15	1	1
CO	750418	0	7	13	1	1
CO	750419	12	12	16	6	-6
CO	750420	10	19	13	10	0
CO	750421	0	8	10	1	1
CO	750422	0	5	8	1	1
CO	750423	0	8	11	1	1
CO	750424	0	6	9	1	1
CO	750425	0	6	11	1	1
CO	750426	0	7	12	1	1
CO	750427	0	7	13	1	1
CO	750428	12	12	13	6	-6
CO	750429	10	17	13	9	-1
CO	750430	12	11	12	3	-9
RI	750401	0	9	15	1	1
RI	750402	0	9	16	1	1
RI	750403	12	10	12	1	-11
RI	750404	0	5	11	1	1
RI	750405	0	4	9	1	1
RI	750406	0	5	13	1	1
RI	750407	0	6	11	1	1
RI	750408	0	3	8	1	1
RI	750409	0	5	15	1	1
RI	750410	0	7	12	1	1
RI	750411	0	6	14	1	1
RI	750412	0	9	14	1	1
RI	750413	0	8	14	1	1
RI	750414	0	5	8	1	1
RI	750415	0	4	10	1	1
RI	750416	0	6	14	1	1
RI	750417	0	4	15	1	1
RI	750418	0	6	11	1	1
RI	750419	0	9	16	1	1
RI	750420	11	18	15	8	-3
RI	750421	11	11	12	2	-9
RI	750422	0	5	11	1	1
RI	750423	0	7	10	1	1
RI	750424	0	8	11	1	1
RI	750425	0	5	10	1	1
RI	750426	0	5	12	1	1
RI	750427	0	7	14	1	1
RI	750428	14	11	14	2	-12
RI	750429	12	15	15	6	-6
RI	750430	10	13	10	6	-4

this category. Figures 4, 5, and 6 illustrate the diurnal ozone concentration/time variation for Riverside, the representative ozone concentration for the N-zone (N for north), and the Corona ozone concentration variation for the S-zone (S for south) for April 20, 29, and 30, respectively.

Table 4. Hourly Difference of Ozone Concentration from the Monitoring Stations of Corona and Riverside for Type II Days During the "Day" Hours of April 1975

Δ (Riverside-Corona)	Number of Events	Partial Percent	Cumulative Percent
-4	1	0.02	0.02
-3	3	0.07	0.09
-2	4	0.08	0.17
-1	7	0.15	0.33
0	8	0.17	0.50
1	13	0.28	0.78
2	5	0.11	0.89
3	4	0.09	0.98
4	1	0.02	1.00

Thus far we have investigated the days with at least one hourly ozone concentration of 10 pphm or more; Type I days with readings of lower than the designated demarcation value have to be studied. Following the procedure set in the discussion of the ozone concentration classification (see Section 3.0), we will estimate one ozone concentration value for each day for the "day" hours. An implicit assumption in this approach is the conjecture that due to lack of structure or, what is the same, due to lack of ozone concentration variability, there will be no hourly concentration which is different from the representative ozone concentration by more

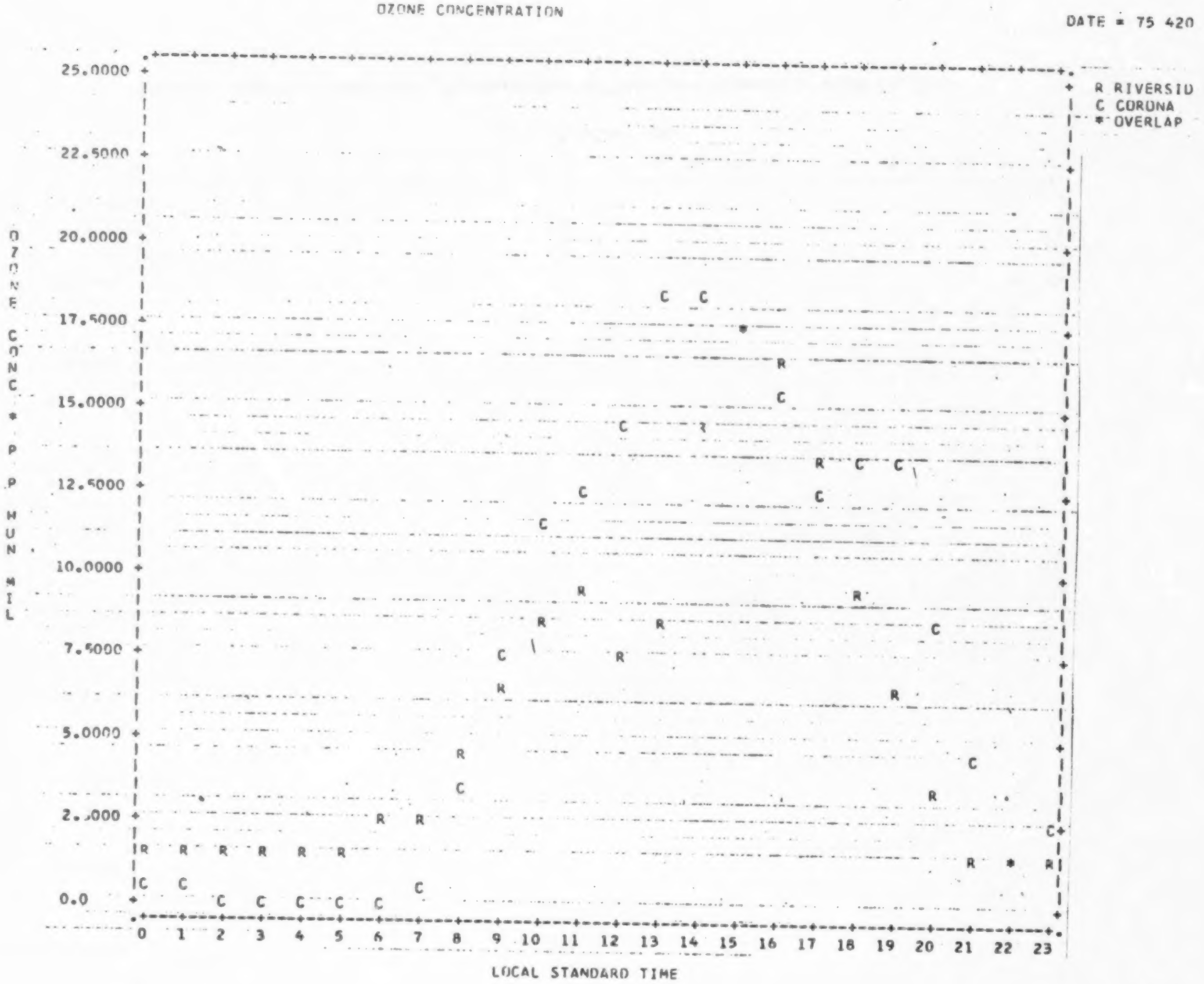

Figure 4. Diurnal Variation of O_3 Concentrations in Corona and Riverside for April 20, 1975

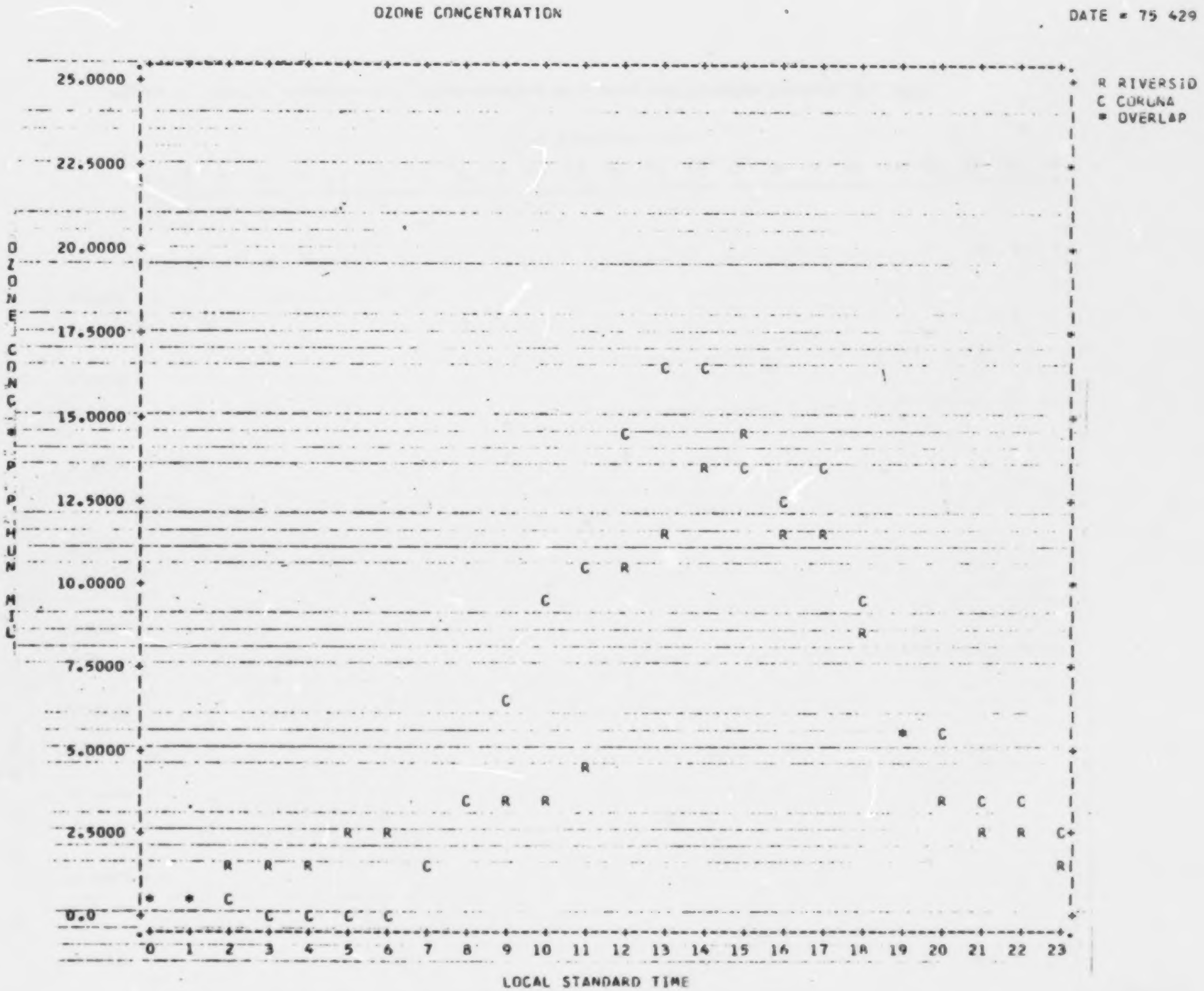

Figure 5. Diurnal Variation of O_3 Concentrations in Corona and Riverside for April 29, 1975

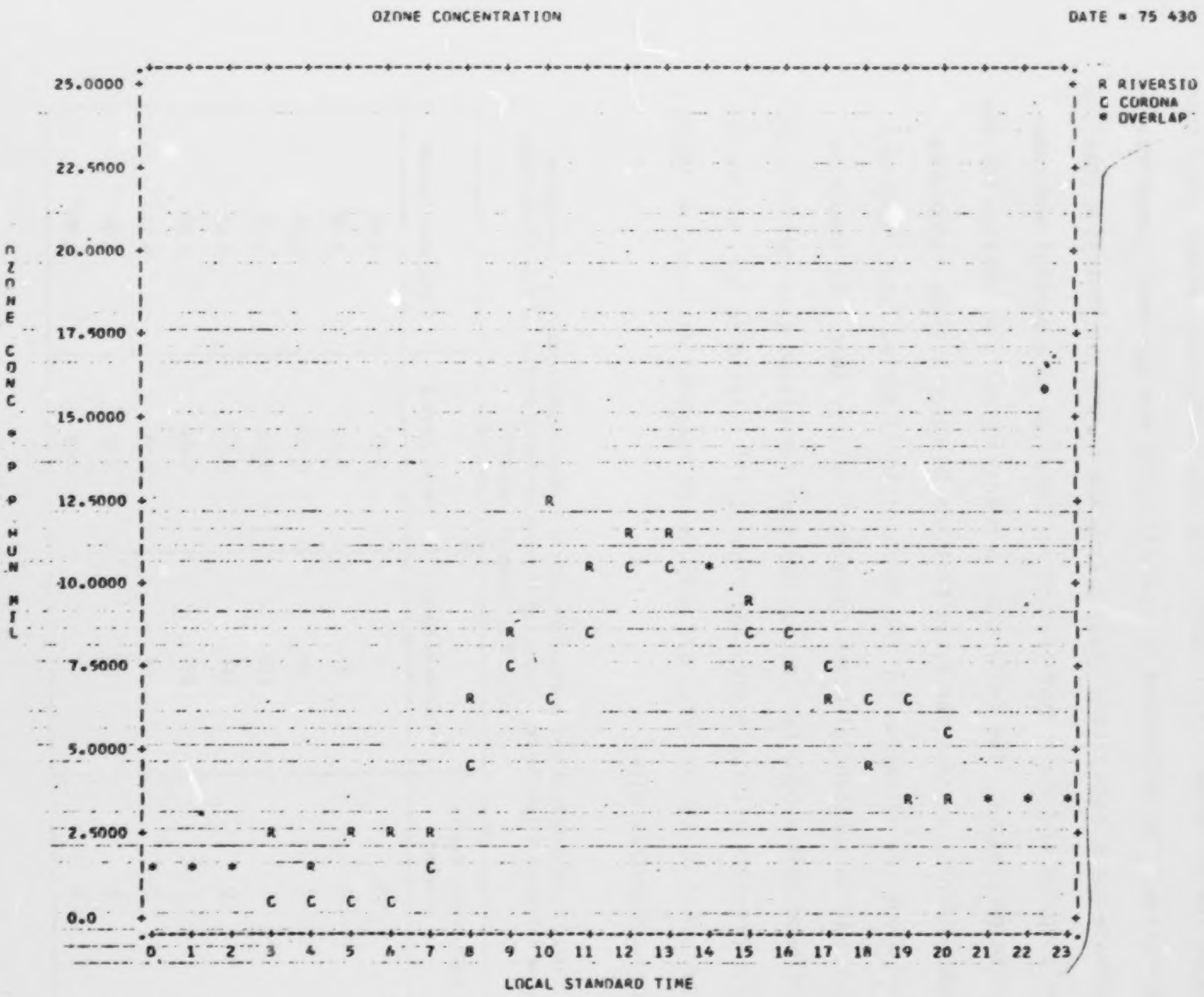

Figure 6. Diurnal Variation of O_3 Concentration in Corona and Riverside for April 30, 1975

than ± 5 pphm. This premise is explicitly checked in Table 5 which illustrates the difference distribution from the calculated average ozone concentration. The difference between the daily average ozone concentration estimate minus each hourly reading from the Corona and Riverside stations are computed and their distribution is indicated as a partial and cumulative percentage. The table shows a nearly normal distribution for the above difference, thus verifying that the computed average representative ozone concentration for the month of April during "day" hours and days with no substantial ozone concentration structure. It should be mentioned that a computer program has been formulated (see Section 5.0) which provides all the tables and figures illustrated so far, allows for a judgement by the analyst, and outputs the required daily and/or hourly ozone concentration(s).

Table 5. Distribution of the Difference Between the Average Representative O_3 Concentration Value and Hourly Values from the Corona and Riverside Monitoring Stations for Type I Days During the "Day" Hours of April 1975

Δ(Riverside, Corona - Average)	Number of Events	Partial Percent	Cumulative Percent
-4	4	0.01	0.01
-3	23	0.04	0.05
-2	46	0.08	0.13
-1	115	0.21	0.34
0	151	0.27	0.62
1	139	0.25	0.87
2	58	0.11	0.98
3	12	0.02	1.00
4	1	0.00	1.00

May 1975

Following the order outlined for the month of April, we begin by computing the background ozone which is the sum of the arithmetic mean of the "night" hours for the two monitoring stations plus a correction term of half the standard deviation; the representative ozone concentration for the month of May is 1.93 + 0.91 = 2.84 ≅ 3.00 pphm. Comments made for the month of April hold true for May and the subsequent months. Figure 7 indicates the distribution of ozone concentration during these hours for the duration of May 1975.

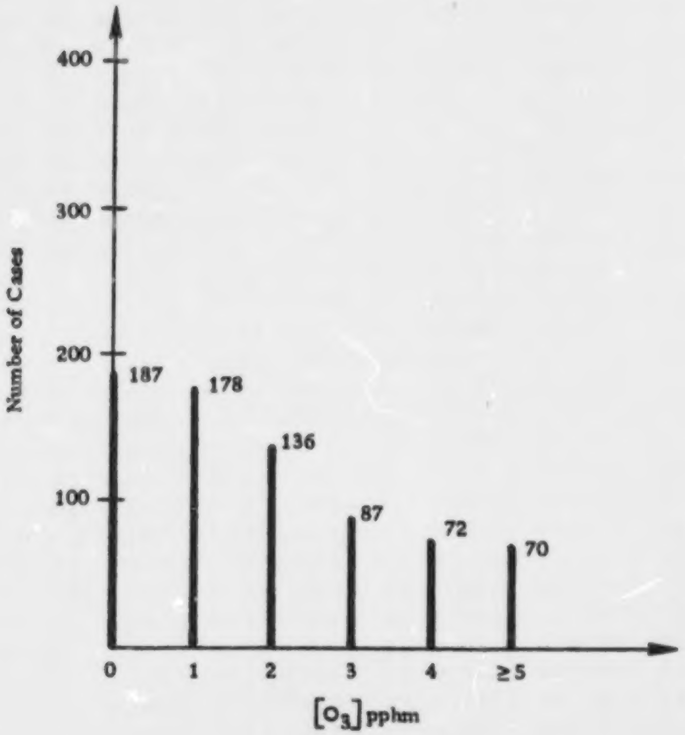

Figure 7. Distribution of Ozone Concentration for the "Night" Hours During the Month of May 1975

There are 14 Type III days during the month of May as is indicated in Table 6.

Table 6. Ozone Concentration Difference Between Corona and Riverside for Days with Difference Greater or Equal to 5 pphm; May 1975

```
DAY=  2 HOUR= 12 CORONA CONC= 20 RIVERSIDE CONC= 14 DIFF=  6
DAY=  2 HOUR= 13 CORONA CONC= 23 RIVERSIDE CONC= 16 DIFF=  7
DAY=  3 HOUR= 10 CORONA CONC=  9 RIVERSIDE CONC= 14 DIFF= -5
DAY=  7 HOUR= 13 CORONA CONC= 14 RIVERSIDE CONC=  9 DIFF=  5
DAY=  9 HOUR= 11 CORONA CONC= 15 RIVERSIDE CONC= 10 DIFF=  5
DAY=  9 HOUR= 12 CORONA CONC= 16 RIVERSIDE CONC= 11 DIFF=  5
DAY=  9 HOUR= 13 CORONA CONC= 23 RIVERSIDE CONC= 11 DIFF= 12
DAY=  9 HOUR= 14 CORONA CONC= 23 RIVERSIDE CONC= 14 DIFF=  9
DAY=  9 HOUR= 15 CORONA CONC= 24 RIVERSIDE CONC= 19 DIFF=  5
DAY= 10 HOUR=  9 CORONA CONC= 16 RIVERSIDE CONC= 11 DIFF=  5
DAY= 10 HOUR= 10 CORONA CONC= 19 RIVERSIDE CONC= 13 DIFF=  6
DAY= 10 HOUR= 11 CORONA CONC= 20 RIVERSIDE CONC= 14 DIFF=  6
DAY= 10 HOUR= 14 CORONA CONC= 26 RIVERSIDE CONC= 18 DIFF=  8
DAY= 10 HOUR= 15 CORONA CONC= 23 RIVERSIDE CONC= 17 DIFF=  6
DAY= 11 HOUR= 12 CORONA CONC= 16 RIVERSIDE CONC= 10 DIFF=  6
DAY= 11 HOUR= 13 CORONA CONC= 17 RIVERSIDE CONC= 12 DIFF=  5
DAY= 12 HOUR= 10 CORONA CONC= 19 RIVERSIDE CONC= 24 DIFF= -5
DAY= 12 HOUR= 11 CORONA CONC= 20 RIVERSIDE CONC= 25 DIFF= -5
DAY= 12 HOUR= 13 CORONA CONC= 23 RIVERSIDE CONC= 33 DIFF=-10
DAY= 12 HOUR= 14 CORONA CONC= 17 RIVERSIDE CONC= 26 DIFF= -9
DAY= 13 HOUR= 11 CORONA CONC= 13 RIVERSIDE CONC= 20 DIFF= -7
DAY= 13 HOUR= 12 CORONA CONC= 15 RIVERSIDE CONC= 24 DIFF= -9
DAY= 13 HOUR= 13 CORONA CONC= 16 RIVERSIDE CONC= 24 DIFF= -8
DAY= 13 HOUR= 14 CORONA CONC= 14 RIVERSIDE CONC= 23 DIFF= -9
DAY= 13 HOUR= 15 CORONA CONC= 10 RIVERSIDE CONC= 17 DIFF= -7
DAY= 13 HOUR= 16 CORONA CONC=  6 RIVERSIDE CONC= 12 DIFF= -6
DAY= 14 HOUR= 12 CORONA CONC= 12 RIVERSIDE CONC= 17 DIFF= -5
DAY= 14 HOUR= 14 CORONA CONC= 15 RIVERSIDE CONC= 20 DIFF= -5
DAY= 15 HOUR= 14 CORONA CONC=  9 RIVERSIDE CONC= 14 DIFF= -5
DAY= 23 HOUR=  9 CORONA CONC=  5 RIVERSIDE CONC= 10 DIFF= -5
DAY= 23 HOUR= 10 CORONA CONC=  9 RIVERSIDE CONC= 14 DIFF= -5
DAY= 23 HOUR= 11 CORONA CONC= 11 RIVERSIDE CONC= 16 DIFF= -5
DAY= 23 HOUR= 17 CORONA CONC= 16 RIVERSIDE CONC= 11 DIFF=  5
DAY= 23 HOUR= 18 CORONA CONC= 14 RIVERSIDE CONC=  9 DIFF=  5
DAY= 23 HOUR= 19 CORONA CONC= 10 RIVERSIDE CONC=  5 DIFF=  5
DAY= 29 HOUR= 11 CORONA CONC= 11 RIVERSIDE CONC=  5 DIFF=  6
DAY= 29 HOUR= 12 CORONA CONC= 14 RIVERSIDE CONC=  5 DIFF=  9
DAY= 29 HOUR= 13 CORONA CONC= 14 RIVERSIDE CONC=  5 DIFF=  9
DAY= 30 HOUR= 12 CORONA CONC= 26 RIVERSIDE CONC= 16 DIFF= 10
DAY= 30 HOUR= 14 CORONA CONC= 27 RIVERSIDE CONC= 22 DIFF=  5
DAY= 30 HOUR= 15 CORONA CONC= 27 RIVERSIDE CONC= 22 DIFF=  5
DAY= 31 HOUR= 11 CORONA CONC= 11 RIVERSIDE CONC= 16 DIFF= -5
```

The advective index table, Table 7, for the month of May shows for Corona nine Type II days. The number of similar Type II days for Riverside is eight; since some of the above days do not coincide, there is a total of 10 days, for May, falling in this category. During these days, representative hourly values will be chosen for the "day" hours. Each hourly value denotes the [O_3] for the total subject area. Table 8 further verifies that one hourly average value is indicative of the ozone concentration for this category. The computer program will select these days and will output the representative value which is the hourly arithmetic average of the two available monitoring stations. The apparent difference between the number of events expected for 10 days, 120 hours, and the indicated number of events, 78 hours, is due to missing data.

During May there are 14 Type III days. One value cannot represent the ozone distribution over the Riverside metropolitan area. Two values are necessary, each representing one geographic zone. The two zones have already been defined. The steps that follow are used to strengthen the validity of this choice. Studies by Zeldin[12], Anderson[2], and Arnold[3] strongly suggest this geographic separation. Figure 8b shows the wind roses for the stations that are relevant in the geographic zone. The diagrams below the computer write-up for the wind roses illustrate the persistent wind directions and further strengthen the two zone advective mechanisms. (Persistent wind direction for purposes of the present study is the wind direction that occurs for at least 10 percent of the month.) In contrast to the above directions the wind rose for Corona and the persistent wind direction (see Figure 9) for the month of May suggest a

Table 7. The Advection Numbers for Corona and Riverside for the Month of May 1975

STAT	DATE	F	MAX CONC	TIME MAX	H	A
CO	750501	12	12	13	3	-9
CO	750502	9	23	13	9	0
CO	750503	11	10	11	3	-8
CO	750504	0	7	0	1	1
CO	750505	0	7	13	1	1
CO	750506	0	9	15	1	1
CO	750507	10	16	14	7	-3
CO	750508	11	13	12	3	-8
CO	750509	11	24	15	7	-4
CO	750510	9	26	14	9	0
CO	750511	9	17	13	10	1
CO	750512	8	23	13	9	1
CO	750513	11	16	13	5	-6
CO	750514	11	15	13	7	-4
CO	750515	12	11	16	5	-7
CO	750516	0	7	13	1	1
CO	750517	10	20	14	8	-2
CO	750518	12	11	12	2	-10
CO	750519	0	6	16	1	1
CO	750520	0	5	12	1	1
CO	750521	0	6	9	1	1
CO	750522	12	11	12	2	-10
CO	750523	11	19	14	9	-2
CO	750524	11	16	14	8	-3
CO	750525	12	12	14	4	-8
CO	750526	12	16	14	6	-6
CO	750527	0	5	16	1	1
CO	750528	11	15	12	8	-3
CO	750529	11	14	12	7	-4
CO	750530	10	27	14	9	-1
CO	750531	10	17	13	9	-1
RI	750501	13	12	14	3	-10
RI	750502	10	20	15	9	-1
RI	750503	9	14	10	4	-5
RI	750504	0	5	13	1	1
RI	750505	0	7	15	1	1
RI	750506	0	7	11	1	1
RI	750507	14	12	14	2	-12
RI	750508	10	13	13	5	-5
RI	750509	11	19	15	7	-4
RI	750510	9	21	13	9	0
RI	750511	9	16	14	10	1
RI	750512	8	33	13	10	2
RI	750513	10	24	12	7	-3
RI	750514	11	20	14	8	-3
RI	750515	10	14	14	8	-2
RI	750516	12	10	12	1	-11
RI	750517	10	22	14	8	-2
RI	750518	12	10	12	2	-10
RI	750519	0	6	16	1	1
RI	750520	0	5	14	1	1
RI	750521	0	6	12	1	1
RI	750522	10	13	13	5	-5
RI	750523	9	20	13	9	0
RI	750524	14	13	14	3	-11
RI	750525	0	9	14	1	1
RI	750526	0	9	11	1	1
RI	750527	0	3	0	1	1
RI	750528	12	15	13	4	-8
RI	750529	14	15	15	4	-10
RI	750530	10	24	16	10	0
RI	750531	10	17	14	10	0

Table 8. Hourly Difference of Ozone Concentrations from the Monitoring Stations of Corona and Riverside for Type II Days During the "Day" Hours of May 1975

Δ (Riverside-Corona)	Number of Events	Partial Percent	Cumulative Percent
-4	0	0.00	0.00
-3	5	0.07	0.07
-2	10	0.13	0.20
-1	18	0.24	0.43
0	24	0.32	0.43
1	9	0.12	0.87
2	6	0.08	0.95
3	4	0.05	1.00
4	0	0.00	1.00

CHINO MAY WIND ROSE

	0	WIND SPEED (MPH) 1-5	6-12	GT.12	S.TOT
N	0 0.0	2 0.5	1 0.3	0 0.0	3 0.8
NNE	0 0.0	7 1.8	0 0.0	0 0.0	7 1.8
NE	0 0.0	2 0.5	0 0.0	0 0.0	2 0.5
ENE	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
E	0 0.0	1 0.3	0 0.0	0 0.0	1 0.3
ESE	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
SE	0 0.0	1 0.3	0 0.0	0 0.0	1 0.3
SSE	0 0.0	4 1.1	0 0.0	0 0.0	4 1.1
S	0 0.0	39 10.3	3 0.8	0 0.0	42 11.1
SSW	0 0.0	63 16.6	0 0.0	0 0.0	63 16.6
SW	0 0.0	82 21.6	0 0.0	0 0.0	82 21.6
WSW	0 0.0	53 14.0	0 0.0	0 0.0	53 14.0
W	0 0.0	36 9.5	0 0.0	0 0.0	36 9.5
WNW	0 0.0	13 3.4	0 0.0	0 0.0	13 3.4
NW	0 0.0	9 2.4	0 0.0	0 0.0	9 2.4
NNW	0 0.0	7 1.8	0 0.0	0 0.0	7 1.8
CALM	56 14.8	0 0.0	0 0.0	0 0.0	56 14.8
S.TOT	56 14.8	319 84.2	4 1.1	0 0.0	379 100.0

TOTAL # OF OBSERVATIONS 379

RIVERSIDE MAY WIND ROSE

	0	WIND SPEED (MPH) 1-5	6-12	GT.12	S.TOT
N	0 0.0	5 0.7	0 0.0	0 0.0	5 0.7
NNE	0 0.0	3 0.4	2 0.3	3 0.4	8 1.1
NE	0 0.0	5 0.7	0 0.0	0 0.0	5 0.7
ENE	0 0.0	5 0.7	0 0.0	0 0.0	5 0.7
E	0 0.0	8 1.1	0 0.0	0 0.0	8 1.1
ESE	0 0.0	6 0.8	0 0.0	0 0.0	6 0.8
SE	0 0.0	7 1.0	0 0.0	0 0.0	7 1.0
SSE	0 0.0	8 1.1	0 0.0	0 0.0	8 1.1
S	0 0.0	14 1.9	0 0.0	0 0.0	14 1.9
SSW	0 0.0	8 1.1	0 0.0	0 0.0	8 1.1
SW	0 0.0	15 2.1	1 0.1	0 0.0	16 2.2
WSW	0 0.0	10 1.4	1 0.1	0 0.0	11 1.5
W	0 0.0	31 4.3	11 1.5	2 0.3	44 6.1
WNW	0 0.0	91 12.6	114 15.7	88 12.1	293 40.4
NW	0 0.0	67 9.2	51 7.0	10 1.4	128 17.7
NNW	0 0.0	46 6.3	2 0.3	0 0.0	48 6.6
CALM	111 15.3	0 0.0	0 0.0	0 0.0	111 15.3
S.TOT	111 15.3	329 45.4	182 25.1	103 14.2	725 100.0

TOTAL # OF OBSERVATIONS 725

REDLANDS MAY WIND ROSE

	0	WIND SPEED (MPH) 1-5	6-12	GT.12	S.TOT
N	0 0.0	111 15.0	3 0.4	5 0.7	119 16.0
NNE	0 0.0	10 1.3	1 0.1	0 0.0	11 1.5
NE	0 0.0	2 0.3	0 0.0	0 0.0	2 0.3
ENE	0 0.0	3 0.4	0 0.0	0 0.0	3 0.4
E	0 0.0	9 1.2	0 0.0	0 0.0	9 1.2
ESE	0 0.0	22 3.0	0 0.0	0 0.0	22 3.0
SE	0 0.0	20 2.7	0 0.0	0 0.0	20 2.7
SSE	0 0.0	51 6.9	0 0.0	0 0.0	51 6.9
S	0 0.0	29 3.9	6 0.8	0 0.0	35 4.7
SSW	0 0.0	10 1.3	1 0.1	0 0.0	11 1.5
SW	0 0.0	4 0.5	1 0.1	0 0.0	5 0.7
WSW	0 0.0	9 1.2	0 0.0	0 0.0	9 1.2
W	0 0.0	41 5.5	15 2.0	0 0.0	56 7.5
WNW	0 0.0	102 13.7	60 8.1	0 0.0	162 21.8
NW	0 0.0	85 11.5	24 3.2	0 0.0	109 14.7
NNW	0 0.0	99 13.3	16 2.2	0 0.0	115 15.5
CALM	3 0.4	0 0.0	0 0.0	0 0.0	3 0.4
S.TOT	3 0.4	607 81.8	127 17.1	5 0.7	742 100.0

TOTAL # OF OBSERVATIONS 742

Figure 8a. Computerized Wind Roses for May for Three Stations in or Nearby the Northern Geographic Zone

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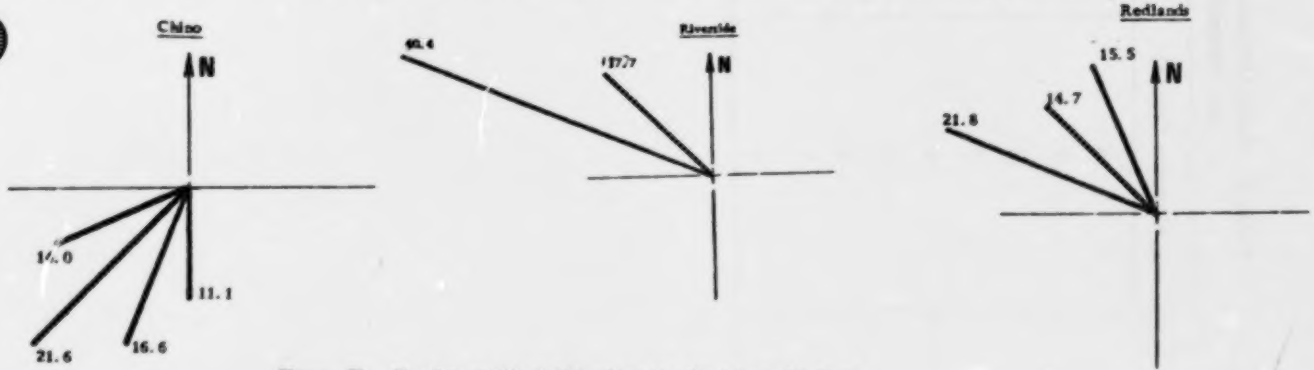

Figure 8b. Persistent Wind Direction for the Same Stations

```
CORONA MAY WIND ROSE

                      WIND SPEED (MPH)
             0       1-5      6-12     GT.12     S.TOT
  N          0         3         0         0         3
           0.0       0.4       0.0       0.0       0.4

  NNE        0        23         0         0        23
           0.0       3.1       0.0       0.0       3.1

  NE         0        12         0         0        12
           0.0       1.6       0.0       0.0       1.6

  ENE        0        16         0         0        16
           0.0       2.2       0.0       0.0       2.2

  E          0        18         0         0        18
           0.0       2.4       0.0       0.0       2.4

  ESE        0         5         0         0         5
           0.0       0.7       0.0       0.0       0.7

  SE         0         7         0         0         7
           0.0       0.9       0.0       0.0       0.9

  SSE        0         3         0         0         3
           0.0       0.4       0.0       0.0       0.4

  S          0         8         0         0         8
           0.0       1.1       0.0       0.0       1.1

  SSW        0        15         0         1        16
           0.0       2.0       0.0       0.1       2.2

  SW         0        23        15         4        42
           0.0       3.1       2.0  [illegible] [illegible]

  WSW        0        33        49        23       105
           0.0       4.4       6.6       3.1      14.1

  W          0        50        97        55       202
           0.0       6.7      13.1       7.4      27.2

  WNW        0        45        35         5        85
           0.0       6.1       4.7       0.7      11.4

  NW         0        38         4         0        42
           0.0       5.1       0.5       0.0       5.7

  NNW        0        51         2         0        53
           0.0       6.9       0.3       0.0       7.1

  CALM     103         0         0         0       103
          13.9       0.0       0.0       0.0      13.9


  S.TOT    103       350       202        88       743
          13.9      47.1      27.2      11.8     100.0

  TOTAL # OF OBSERVATIONS=  743
```

Figure 9a. Wind Rose for Corona During May 1975

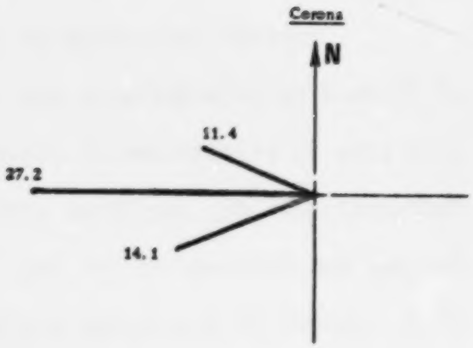

Figure 9b. Persistent Wind Direction for Corona During May 1975

different wind flow channel for the southern segment of the Riverside metropolitan area. The wind direction from Santa Ana Canyon station, provided by the Orange County zone of the APCD, is such that it allows for the possibility of two distinct flow patterns immediately after the end of the Santa Ana Canyon.

Further indication of an advection mechanism involving the axis of Chino-Riverside-Redlands and covering the northern sector of the subject area is illustrated in Figure 10. It is observed that during this representative day the three stations peak in order with Chino leading the way and Redlands at the end. Furthermore, the second less pronounced peak, typical of high ozone concentration days, also suggests an advection mechanism. It must be emphasized that all the monitoring instruments in the various counties in southern California are calibrated by State authorities and no correction factors are needed. Since there are no neighboring stations to the Corona station, data from this station are utilized for the southern zone on the basis of the wind flow patterns and studies by Arnold[3]. The diurnal wind direction and speed variations is also checked on all pertinent days to verify that the flow patterns assumed are not contradicted by the data from the various stations.

Even though the wind data from the various stations are subject to local topographic influences[13,7,3], and thus suspect, it is encouraging to point out that the daily data utilized strengthen the hypotheses made in this study with respect to meteorology. The daily data from the southern California APCD are assumed to be a secondary source used to verify the wind flow patterns suggested by scientific works specifically designed to study

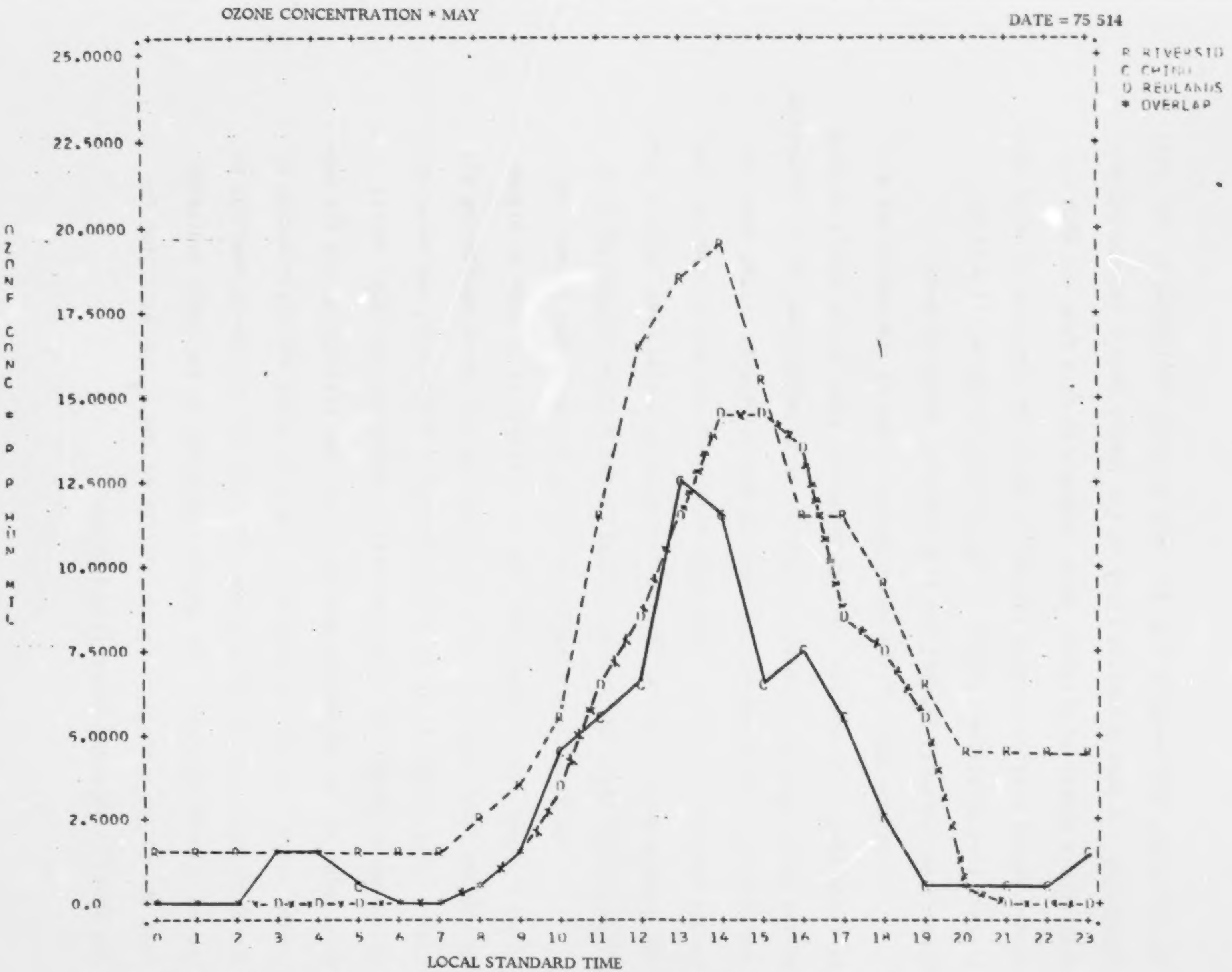

Figure 10. Typical Diurnal O_3 Concentration Variations for the Three Stations in the Northern Geographic Zone. The orders of maximum concentration and the presence of double peak suggest an advective mechanism.

the patterns, only because they are very strongly influenced by the local topography. A more extensive study in the future should incorporate wind data from a number of airports which, along with data from the APCD stations, should provide a sound scientific basis for the generation of persistent wind direction patterns. The existing evidence, it must be emphasized, strongly support the flow patterns presented here.

On the basis of the above analysis, two O_3 concentrations will be calculated. The one for the N-geographical zone is the hourly average of the three stations involved in the advective mechanisms, Chino, Riverside, and Redlands. The S-geographic zone assumes the hourly values from the Corona monitoring station. The distribution of the hourly readings from the average hourly reading for the N-geographic sector (see Table 9) provides a final check on how representative the N-ozone concentration is.

The last classification of the O_3 concentration diurnal variation includes Type I days which show no readings of 10 pphm or higher during the "day" hours for both the Riverside and Corona monitoring stations. Since there is no O_3 structure during these days, one value will be chosen to denote the O_3 concentration throughout the "day" hours; this value is the arithmetic average of all the readings during the pertinent hours from the two stations. Table 10 shows the distribution of the difference between the average value and all the hourly readings of the no "structure" days. The symmetry observed in the table indicates that the chosen average is representative of the O_3 concentration for the specific days and hours investigated.

Table 9. Distribution of the Difference Between the Average Representative O_3 Concentration and Hourly Values from Chino, Riverside and Redlands Monitoring Stations for Type III Days for the Month of May 1975

Δ (Riverside, Chino, Redlands - Average)	Number of Events	Partial Percent	Cumulative Percent
-10	1	0.00	0.00
-9	0	0.00	0.00
-8	2	0.00	0.00
-7	8	0.02	0.04
-6	8	0.02	0.06
-5	13	0.03	0.09
-4	21	0.04	0.13
-3	29	0.06	0.19
-2	53	0.11	0.30
-1	80	0.16	0.46
0	73	0.15	0.61
1	82	0.17	0.78
2	42	0.07	0.85
3	42	0.07	0.92
4	16	0.03	0.95
5	11	0.02	0.97
6	8	0.02	0.99
7	5	0.01	1.00
8	2	0.00	1.00
9	0	0.00	1.00
10	1	0.00	1.00
11	1	0.00	1.00

Table 10. Distribution of the Difference Between the Average Representative O_3 Concentration Value and Hourly Values from the Corona and Riverside Monitoring Stations for Type I days during the "Day" Hours of May 1975

Δ (Riverside, Corona - Average)	Number of Events	Partial Percent	Cumulative Percent
-5	1	0.01	0.01
-4	1	0.01	0.01
-3	5	0.04	0.05
-2	13	0.09	0.14
-1	19	0.13	0.27
0	46	0.32	0.60
1	37	0.26	0.86
2	16	0.11	0.97
3	4	0.03	1.00

While we shall not explicitly state all the steps taken in the analysis of the subsequent months, we must emphasize that the process was repeated for every month, all options were investigated and the choices were verified within the limits stated in this section.

In the balance of this section, the facts and necessary supporting material will be summarized without a detailed analysis which, of course, follows the steps outlined in the investigation of April and May.

June 1975

For the month of June the background O_3 concentration is 1.29 + 0.68 = 1.97 $\cong$ 2.00 pphm; Figure 11 shows the distribution of ozone concentration for the "night" hour after June 1975.

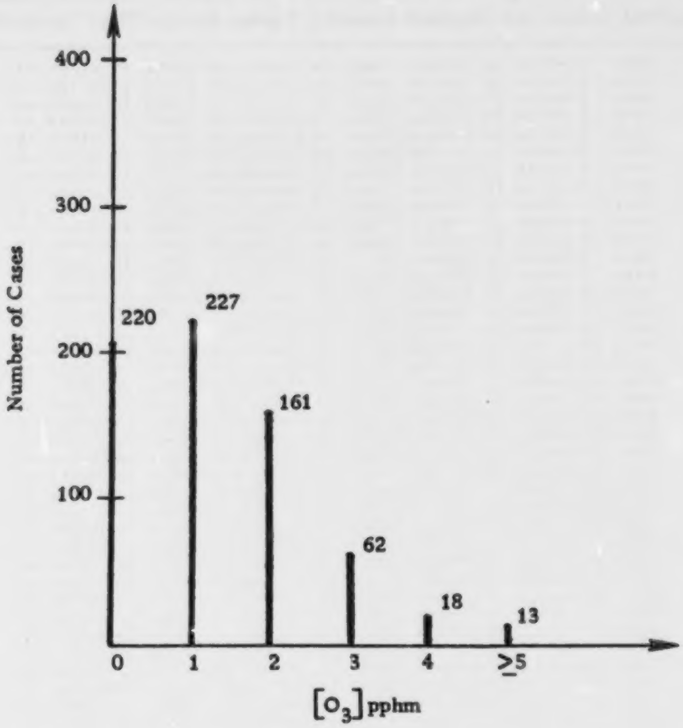

Figure 11. Distribution of O_3 Concentration Hourly Readings for the "Night" Hours of June 1975

Table 11 provides the number of days and hours for Type III days. During June, there are 21 such days which require two hourly readings for the subject area, one for the N-geographic zone and the other for the S-geographic zone. Data from the advective index table, Table 12, suggest the possibility of advective mechanisms that cause the high O_3 concentrations, and point out the daily maximum ozone concentrations and the number of hours during a given day with O_3 concentrations of 10 pphm or higher. There are seven Type II days during June 1975, one hourly ozone concentration will denote the ozone levels for the total area. There are no days during June when both stations record hourly readings of less than 10 pphm throughout the "day" hours.

Table 11. Days and Hours During Which the Difference Between the Respective Hourly O_3 Concentration Readings from Corona and Riverside Exceed ± 5 pphm for the "Day" Hours of June 1975

```
DAY=  1 HOUR= 14 CORONA CONC= 10 RIVERSIDE CONC= 17 DIFF= -7
DAY=  1 HOUR= 15 CORONA CONC= 10 RIVERSIDE CONC= 17 DIFF= -7
DAY=  1 HOUR= 16 CORONA CONC= 10 RIVERSIDE CONC= 16 DIFF= -6
DAY=  2 HOUR= 15 CORONA CONC=  8 RIVERSIDE CONC= 15 DIFF= -7
DAY=  3 HOUR= 14 CORONA CONC=  4 RIVERSIDE CONC=  9 DIFF= -5
DAY=  5 HOUR= 12 CORONA CONC= 10 RIVERSIDE CONC= 16 DIFF= -6
DAY=  5 HOUR= 15 CORONA CONC= 10 RIVERSIDE CONC= 21 DIFF=-11
DAY=  5 HOUR= 16 CORONA CONC= 12 RIVERSIDE CONC= 18 DIFF= -6
DAY=  6 HOUR= 12 CORONA CONC= 15 RIVERSIDE CONC= 20 DIFF= -5
DAY=  6 HOUR= 16 CORONA CONC= 18 RIVERSIDE CONC= 25 DIFF= -7
DAY=  7 HOUR= 10 CORONA CONC=  8 RIVERSIDE CONC= 14 DIFF= -6
DAY=  7 HOUR= 11 CORONA CONC=  9 RIVERSIDE CONC= 15 DIFF= -6
DAY=  7 HOUR= 12 CORONA CONC= 10 RIVERSIDE CONC= 15 DIFF= -5
DAY= 10 HOUR= 13 CORONA CONC= 18 RIVERSIDE CONC= 23 DIFF= -5
DAY= 10 HOUR= 14 CORONA CONC= 18 RIVERSIDE CONC= 26 DIFF= -8
DAY= 10 HOUR= 16 CORONA CONC= 16 RIVERSIDE CONC= 21 DIFF= -5
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DAY= 28 HOUR= 11 CORONA CONC=  7 RIVERSIDE CONC= 16 DIFF= -9
DAY= 28 HOUR= 12 CORONA CONC= 10 RIVERSIDE CONC= 15 DIFF= -5
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DAY= 30 HOUR= 18 CORONA CONC=  9 RIVERSIDE CONC= 15 DIFF= -6
DAY= 30 HOUR= 19 CORONA CONC=  5 RIVERSIDE CONC= 11 DIFF= -6
```

Table 12. The Advection Numbers for Corona and Riverside for the Month of June 1975

STAT	DATE	F	MAX CONC	TIME MAX	H	A
CO	750601	11	14	12	6	-5
CO	750602	12	13	13	3	-9
CO	750603	0	8	12	1	1
CO	750604	0	8	14	1	1
CO	750605	12	13	14	6	-6
CO	750606	11	20	13	6	-5
CO	750607	12	10	12	2	-10
CO	750608	0	7	14	1	1
CO	750609	11	17	13	7	-4
CO	750610	10	18	13	8	-2
CO	750611	10	27	14	9	-1
CO	750612	12	11	13	4	-8
CO	750613	10	14	12	5	-5
CO	750614	10	18	12	8	-2
CO	750615	11	11	11	2	-9
CO	750616	0	6	13	1	1
CO	750617	0	5	13	1	1
CO	750618	0	4	13	1	1
CO	750619	0	3	11	1	1
CO	750620	0	6	12	1	1
CO	750621	10	15	12	8	-2
CO	750622	10	15	13	8	-2
CO	750623	0	9	11	1	1
CO	750624	0	9	14	1	1
CO	750625	10	17	14	6	-4
CO	750626	10	11	11	3	-7
CO	750627	12	11	13	2	-10
CO	750628	12	12	13	4	-8
CO	750629	9	13	10	6	-3
CO	750630	9	11	12	8	-1
RI	750601	10	17	14	8	-2
RI	750602	12	15	14	5	-7
RI	750603	0	9	14	1	1
RI	750604	0	-1	14	1	1
RI	750605	11	21	15	7	-4
RI	750606	10	25	14	8	-2
RI	750607	10	15	11	7	-3
RI	750608	14	10	14	2	-12
RI	750609	11	21	15	7	-4
RI	750610	10	26	14	9	-1
RI	750611	10	31	16	9	-1
RI	750612	10	20	13	8	-2
RI	750613	10	20	13	9	-1
RI	750614	10	20	14	9	-1
RI	750615	11	17	12	6	-5
RI	750616	0	9	15	1	1
RI	750617	0	6	12	1	1
RI	750618	0	4	10	1	1
RI	750619	0	4	14	1	1
RI	750620	0	9	14	1	1
RI	750621	10	20	13	9	-1
RI	750622	10	17	11	9	-1
RI	750623	12	14	13	3	-9
RI	750624	12	11	14	6	-8
RI	750625	11	22	14	7	-4
RI	750626	10	19	13	10	0
RI	750627	9	16	10	9	0
RI	750628	9	16	11	9	0
RI	750629	9	16	13	9	0
RI	750630	9	15	18	11	2

July 1975

Similar steps for the month of July indicate a background average reading for the "night" hours of 1.07 + 0.86 = 1.93 $\cong$ 2.00 pphm, the distribution for these hours is indicated in Figure 12. During the month of July there are 29 Type III days which require two representative hourly O_3 concentrations in order to define the ozone levels in the Riverside metropolitan area. The remaining two days show at least one O_3 concentration of 10 pphm or higher for at least one of the two stations, however their respective hourly differences remain within the prescribed limit. These two days are Type II days and one hourly reading will represent the total subject area.

The necessary distributions and further supporting material, similar to that provided for April and May, are given in Appendix B.

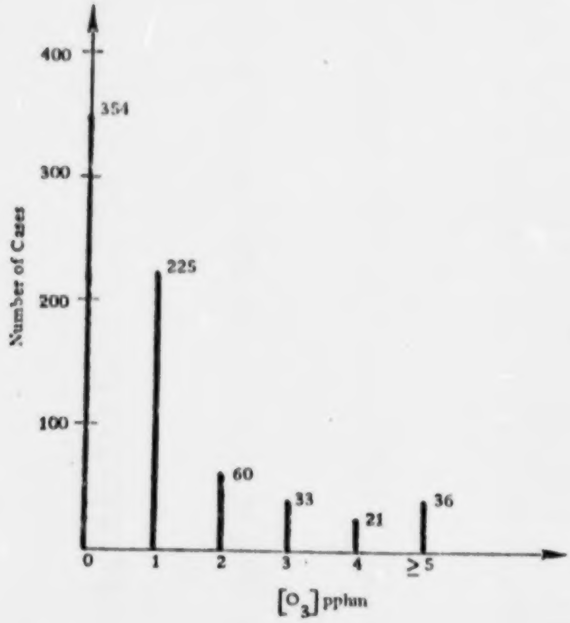


Figure 12. Distribution of Ozone Concentrations for the "Night" Hours During the Month of July 1975

4.2 INCLUSION OF DATA FROM THE MAGNOLIA MONITORING STATION

It is evident, by now, that the developed approach is a month-by-month study based on the ozone concentration gradient between two existing monitoring stations. We have alluded that within the Riverside metropolitan area there exists a third monitoring station operated by the California State Air Resource Board. Data from this station will be utilized to test the approach, increase the geographical zones, when necessary, and verify the procedure on more than two stations. This is done by applying the technique on two additional station sets, the Magnolia-Corona and Magnolia-Riverside, and investigating the results in conjunction with the output from the Corona-Riverside set.

Magnolia is geographically located in the N-zone. During April inclusion of data from Magnolia indicates that the station belongs in the N-zone. For the month of May, from a total of 156 hourly readings of Type III days, only 3 readings would put Magnolia to the S-zone. Continuing with June we find that only 40 hourly readings from a possible 228 would relocate Magnolia to the S-zone; the numbers for July are 18 and 312, respectively. The extent to which these numbers "validate" the approach is judgmental. However, the author feels that the strength of the procedure is its ability to include more data as they become available. Following is a more inclusive approach offering exactly the same procedure on all three sets of data.

If all three relative studies indicate Type I days, one ozone concentration value is calculated for the subject area: the mean of the three stations. If a Type II day is indicated in at least one of the three studied sets, then hourly structure is computed for the Riverside metropolitan area, with the mean of the three hourly readings as the representative value. The persistent windflow patterns, reviewed in previous sections, suggest two basic geographic-pollution zones: the N- and S-zones indicated in Figure 13. The study of the Magnolia ozone concentrations, the local ozone production from downtown Riverside City and the interaction of the two advective wind flow patterns often (not always) necessitates a third zone: the C-zone indicated in Figure 13 by the broken line. The third zone is generated by the three stations' concentration gradient mechanisms, only where the Riverside-Magnolia ozone concentrations indicate a Type III day; any other combination of Type III days will generate two zones. Even though the indicated geographical-pollution zones must be considered as assumptions, it is emphasized that the topography of the area, the persistent wind directions, and the study of the advective index strongly suggest that these are appropriate demarcation lines. Finally, the inclusion of the Magnolia ozone data does not change the monthly background values. Table 13 summarizes the time and space structure for the four month study for the three stations in the Riverside Metropolitan Area.

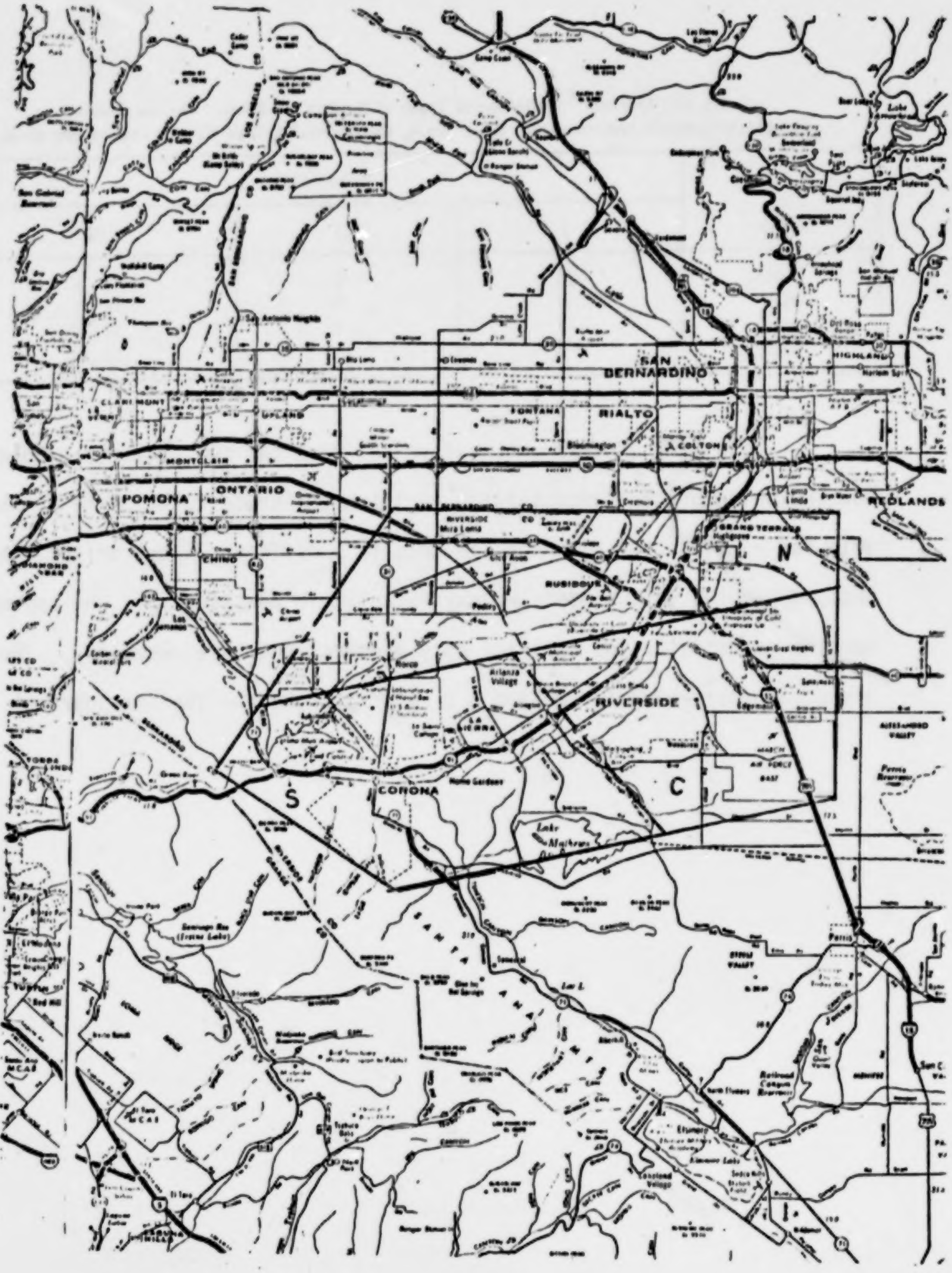

SAN BERNARDINO
HIGHLAND
CLAREMONT
UPLAND
FONTANA
RIALTO
COLTON
MONTCLAIR
POMONA
ONTARIO
REDLANDS
CHINO
RUBIDOUX
N
RIVERSIDE
LA SIERRA
S
CORONA
C
Lake Mathews
SANTA ANA MTS

Figure 13. The Riverside Metropolitan Area, the Three Geographic Zones Indicated from the Applications of the Ozone Concentration Gradient Procedure on Data from the Three Local Monitoring Stations

Table 13. Monthly Distribution of Types of Days in the RMA. The numbers in parentheses indicate days with three space zones, the remaining Type III days require two zones.

Month	Type of Day		
	I	II	III
April	23	2	5 (0)
May	6	7	18 (7)
June	7	1	22 (19)
July	0	1	30 (26)

The bulk of this work refers to first the two stations studied. The inclusion of the third station verifies the study to the extent that only few readings put the Magnolia data in a different zone, or the extent that, depending on our needs we may formulate a denser grid. The approach remains essentially the same and only minor changes are necessary. The discussion appearing in Section 5.0 refers to the two station approach.

Section 5.0

DISCUSSION AND CONCLUSIONS

The temporal and geographical distribution of ozone concentrations in the Riverside metropolitan area has been investigated. The approach taken is unique because it does not seek to estimate the pollution source strength or to define various complex chemical and meteorological kinetic schemes utilized in the past for similar studies. The present work is also unusual because it does not investigate trends over long time-periods or details over short time-intervals, but it puts the foundations for a study of the diurnal ozone level variations in the subject area for the duration of the six-month summer ozone cycle. The resultant mapping over the area uses three sets of criteria: time period, O_3 concentration range, and geographical zones. The step-by-step process begins by defining a time interval of investigation, then (depending on the $[O_3]$ range) defines three classes of "day"-hours days, and finally a choice is made with respect to the area represented by the two monitoring station readings on the basis of the structure of the ozone concentration hourly variation. Figure 12 illustrates the criteria.

A computer program (see Appendix B) has been written which takes under consideration the above criteria and provides the pertinent hourly ozone concentrations for the Riverside metropolitan area; a sample of the monthly output is shown in Figure 13. Appendix B shows the hourly $[O_3]$ variations for the four months investigated as well as a series of distributions which support the approach taken.

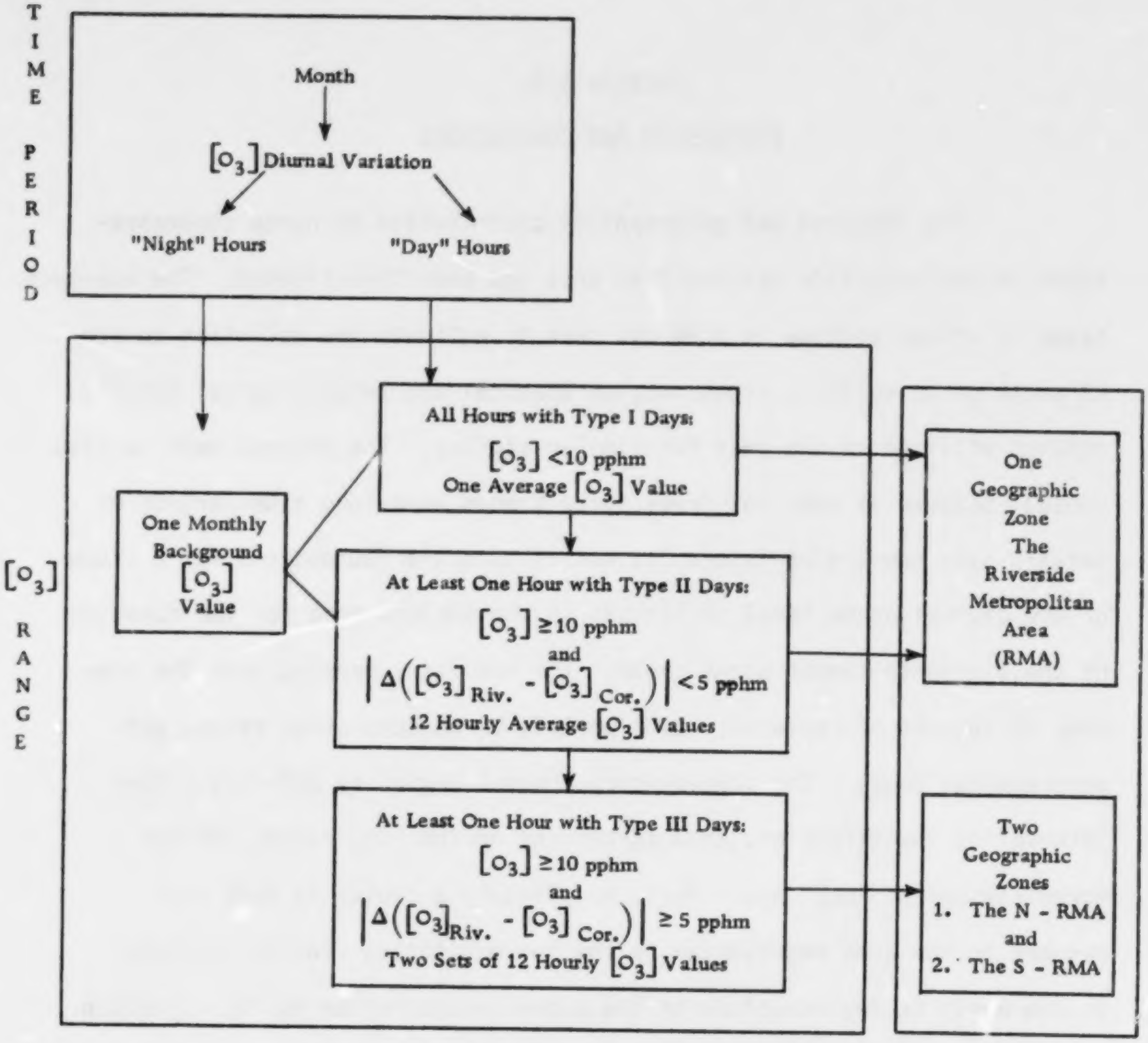

TIME PERIOD
Month
$[O_3]$ Diurnal Variation
"Night" Hours
"Day" Hours
$[O_3]$ RANGE
One Monthly Background $[O_3]$ Value
All Hours with Type I Days:
$[O_3] < 10$ pphm
One Average $[O_3]$ Value
At Least One Hour with Type II Days:
$[O_3] \geq 10$ pphm
and
$\left| \Delta\left([O_3]_{Riv.} - [O_3]_{Cor.}\right) \right| < 5$ pphm
12 Hourly Average $[O_3]$ Values
At Least One Hour with Type III Days:
$[O_3] \geq 10$ pphm
and
$\left| \Delta\left([O_3]_{Riv.} - [O_3]_{Cor.}\right) \right| \geq 5$ pphm
Two Sets of 12 Hourly $[O_3]$ Values
One Geographic Zone The Riverside Metropolitan Area (RMA)
Two Geographic Zones
1. The N - RMA
and
2. The S - RMA
GEOGRAPHIC ZONES

Figure 14. Criteria Used in the Definition of the Ozone Levels with Respect to Time, Concentration, and Space

```
                              MAY  HOURLY VALUES USED

                                                        HOUR
              NT     9      10      11      12      13      14      15      16      17      18      19      20     NT
DAY  TYPE           N  S    N  S    N  S    N  S    N  S    N  S    N  S    N  S    N  S    N  S    N  S    N  S

  1   II       3    6  6    7  7    8  8    9  9   11 11   11 11    9  9    8  8    7  7    5  5    4  4    4  4     3
  2   III      3    8 10   10 15   13 16   14 20   15 23   17 18   17 19   15 14   12 13    9  8    4  4    2  2     3
  3   III      3    7  9   10  9   12 10   11 10   10 10    9  9    7  8    6  6    5  5    4  5    3  6    3  6     3
  4   I        3    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4     3
  5   I        3    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5     3
  6   I        3    6  6    6  6    6  6    6  6    6  6    6  6    6  6    6  6    6  6    6  6    6  6    6  6     3
  7   III      3    7  8    8 10    8 10    9 11   11 14   12 16   12 14   10 10    7  8    6  7    4  5    2  2     3
  8   II       3    8  8    9  9   11 11   12 12   13 13   10 10    8  8    8  8    6  6    3  3    2  2    1  1     3
  9   III      3    6  7    7  8   11 15   12 16   13 23   16 23   18 24   16 15   12 11    8  8    6  5    2  3     3
 10   III      3   10 16   12 19   13 20   14 24   15 23   16 26   16 23   14 17   11 11    9  8    4  4    2  2     3
 11   III      3    9 13   10 15   12 14   13 16    9 17   11 17   16 15   14 15   12 14   10 11    7  7    4  5     3
 12   III      3   14 17   18 19   18 20   22 22   22 23   19 17   13 14   10 11    7  8    4  5    2  2    1  2     3
 13   III      3    6  4    9  8   13 13   16 15   18 16   17 14   14 10    9  6    7  5    5  3    3  3    1  3     3
 14   III      3    3  3    5  6    8 10   11 12   15 15   16 15   13 12   11 11    9 10    7  8    5  6    2  4     3
 15   III      3    5  5    6  6    9  8    9 10   11  9   11  9   11 10   11 11    9  8    6  6    4  5    3  4     3
 16   II       3    6  6    7  7    7  7    8  8    8  8    7  7    6  6    5  5    5  5    3  3    3  3    2  2     3
 17   II       3    9  9   11 11   14 14   17 17   19 19   21 21   19 19   13 13   10 10    7  7    5  5    4  4     3
 18   II       3    5  5    7  7    8  8   10 10   10 10    8  8    6  6    5  5    4  4    3  3    2  2    1  1     3
 19   I        3    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4     3
 20   I        3    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4    4  4     3
 21   I        3    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5    5  5     3
 22   II       3    8  8    9  9    9  9   11 11   11 11   10 10    8  8    6  6    5  5    3  3    2  2    1  1     3
 23   III      3    7  5   11  9   13 11   12 15   19 18   18 19   16 14   12 15   11 16    8 14    5 10    1  5     3
 24   II       3    6  6    9  9   13 13   12 12   14 14   14 14   13 13   12 12    9  9    9  9    8  8    7  7     3
 25   II       3    3  3    7  7    9  9   10 10   11 11   10 10    9  9    7  7    7  7    5  5    4  4    2  2     3
 26   II       3    3  3    5  5    8  8   13 13   13 13   16 16   14 14   12 12    9  9    8  8    5  5    3  3     3
 27   I        3    3  3    3  3    3  3    3  3    3  3    3  3    3  3    3  3    3  3    3  3    3  3    3  3     3
 28   II       3    7  7    9  9   11 11   13 13   14 14   15 15   13 13   10 10    8  8    8  8    6  6    5  5     3
 29   III      3    5  7    7  9    9 11   10 14    7 14    9 13   10 11   10 11   11 10    8  9    6  8    4  5     3
 30   III      3    7  6   12 12   13 17   17 26   20 23   23 27   23 27   23 27   15 22   14 15   10  9    7  4     3
 31   III      3    7  7   12 11   16 11   17 15   18 17   16 17   14 15   13 11   11 14   11 13    8  8    5  5     3
```

Figure 15. Sample Output of the Hourly Ozone Concentrations During the Month of May 1975

Two assumptions were made in the phenomenological approach developed here:

(1) A demarcation line of 10 pphm of ozone concentration was chosen as indicative of a variation that would be useful in a study of ozone concentration dose-response correlation. While the choice is arbitrary it is also highly appropriate because it is the air quality standard for the State of California and very close to the Federal standard (8 pphm). Related to this assumption is a finer subdivision for the hourly difference between the two available stations. Different steps are taken when at least one such hourly difference is larger than 4 pphm. This approach guarantees that the space mapping of the ozone concentration is always within the limit of 10 pphm of ozone.

(2) When necessary we have divided the subject area into two zones. This division was done on the basis of scientific studies for previous years investigating the persistent wind data, and strong indications of the meteorological data obtained from the relevant air pollution monitoring stations. We choose, however, to include the two geographic-zone separation among our assumptions because the wind data are suspect. It is believed that a more detailed study including data from a number of neighboring airports will verify the wind flow patterns.

The following conclusions have been made on the basis of our phenomenological approach:

- It is possible to estimate ambient ozone concentrations levels for the Riverside metropolitan area without assuming a uniform ozone level over the total subject area.
- The practical procedure developed is equally reliable, faster, less expensive, and less complex, than the more detailed and quite involved models.
- The approach outlined in this document can be utilized to cover a larger area and include the total eastern segment of the Los Angeles basin. While the number of monitoring stations will increase, the two basic wind flow patterns utilized in this study will determine the various advection mechanisms substantially controlling the local ozone diurnal behavior.

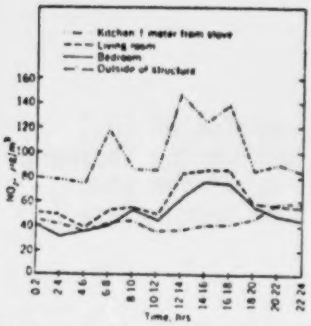
- This procedure of time and space mapping of [O_3] in urban centers can be applied outside the Southern California area. A day-by-day study of the wind patterns is possible anywhere if the appropriate data set is available.

This study is meant to investigate the six-month ozone cycle, however, data for the months of August and September were not available at the time of completion of this phase of the project. The approach undertaken strictly refers to the hourly ambient ozone concentration variability. Further work is needed to investigate the concentration levels of other pollutants, and the relationship between the indoor and outdoor concentrations. With respect to the other primary pollutants, during the ozone cycle months of 1975 only the Riverside monitoring station obtained relevant readings on suspended particulates, CO, NO_2, NO_x, and SO_2 concentrations.

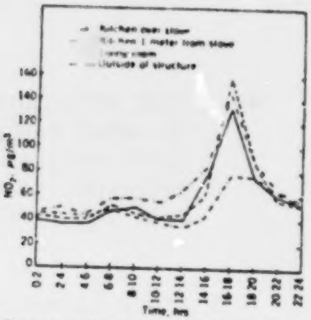
In terms of further steps, it is suggested that a series of correlation studies be undertaken and pertinent hourly concentrations of all the primary pollutants be estimated for the Riverside metropolitan area. The relationship between indoor and outdoor pollution levels might be projected on the basis of an in-depth literature study. Representative results of a preliminary look are summarized in Figure 14 which illustrates some of the findings of relevant scientific work.

In summary, this study has established a procedure which maps ozone concentration readings in time and space from two monitoring stations over the Riverside metropolitan area. The constructed empirical model divided the data in two daily time intervals depending on the ozone concentrations levels, in three types of ozone concentration days depending

(a)

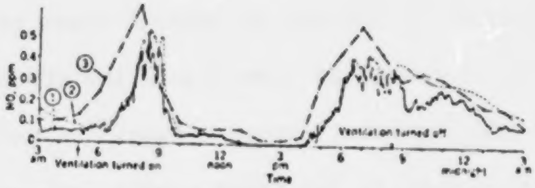


Diurnal indoor/outdoor pattern for NO_2: House #1, spring-summer 1973 (composite day based on 6 days of data)



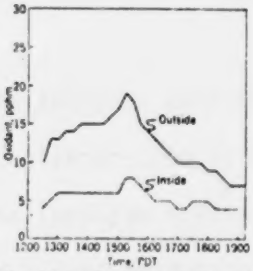
Diurnal indoor/outdoor pattern for NO_2: House # 1, fall 1973 (first half) (composite based on 7 days of data)

(b)

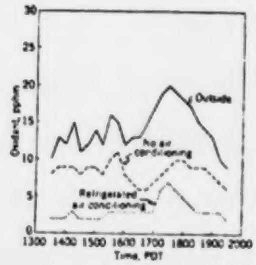


Relative NO levels as recorded outdoors (1), indoors (2), and as reported by the Pasadena APCD station (3) on a typical day

(c)



Total oxidant levels inside and outside university laboratory building with 100% air makeup



Total oxidant levels outside and inside air conditioned military hospital

(a) - W. A. Wade, III, W. A. Cote, and J. E. Yocom [11]

(b) - R. L. Derham, G. Peterson, R. H. Sabersky, and F. H. Shair [4]

(c) - C. R. Thompson, E. G. Hensel, and G. Kats [10]

Figure 16. Literature Illustrations from Indoor/Outdoor Air Pollution Relations

on the maximum hourly ozone average and the structure of the [O_3] variation, and in two geographic areas depending on the advection mechanisms present. Four summer months have been investigated with respect to ozone concentrations. Directions have been set for the estimation of the other primary pollutant diurnal variations and for the study of the indoor-outdoor pollutant relation.

Section 6.0

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Appendix A

PROTOCOL FOR PILOT STUDY DATA COLLECTION AND CODING

The following section presents the data instruments.

PATIENT RECORD ABSTRACT

1. Case No. 1-4

2. Log No. 5-7

3. Hospital No. 8-13

4. E.D. Arrival 14-23
Day: ____ By: Amb. ___(1)
Date: ____ Time: ____ Other ___(2)

5. Sex 24
M ___(1)
F ___(2)

6. Ethnic Group 25
W ___(1) M ___(3)
B ___(2) O ___(4)

7. Age 26-28
d (1)
m (2)
____ y (3)

8. Married 29
Y ___(1)
N ___(2)

9. Residence 30-31
( )

10. Payment 32
I ___(1) M ___(3)
W ___(2) O ___(4)

11. Complaints 33-67

Symptoms	NCHS	Onset: (1)	(2)
____	( )	h	d
____	( )	h	d
____	( )	h	d
____	( )	h	d
____	( )	h	d

12. Condition 68
Alert ____(1)
Agitated ____(2)
Disoriented ____(3)
Unconscious ____(4)

13. Vital Signs 69-73
Temperature: ___( )
Pulse: ___( )
Respiration: ___( )
Blood Pressure: ___( )
___( )

14. Medical History 74-79
Asthma ____(1)
COPD ____(2)
Heart Disease ____(3)
Hypertension ____(4)
Stroke ____(5)
Diabetes ____(6)
Chr. G-I Disease ____(7)
Liver Disease ____(8)
Renal Disease ____(9)

15. Diagnostic Data 5-20
Hgb. ___( )
WBC ___( )
Lymphs ___( )
EOS ___( )
SGOT ___( )
T. Protein ___( )
Albumin ___( )
Globulin ___( )
B ___( )
or U ___( )

Chest Film:
Positive ___(1)
Negative ___(2)

ECG:
Positive ___(1)
Negative ___(2)

Blood Gases:
pH ____
$\underline{P}CO_2$ ____
CO_2 ____
$\underline{P}O_2$ ____
(Code ____)

Electrolytes:
Na ___( )
K ___( )
Cl ___( )
HCO_3 ___( )

16. Treatment 21-25
Injections ____( )
I.V. Fluids ____( )
IPPB ____( )
O_2 (M or N-T) ____( )
CPR ____( )

17. E.D. Diagnosis 26-45

	H-ICDA
____	( )
____	( )
____	( )
____	( )
____	( )

18. E.D. Disposition 46
Discharge: Home ___(1)
ECF ___(2)
Hospital ___(3)
Admit: ICU ___(4)
OR ___(5)
Other ___(6)
Transfer (Acute) ___(7)
Died in E.D.: ___(8)

19. Admission Data 47-68
LOS ____ d

Discharge Dx:	H-ICDA
____	( )
____	( )
____	( )
____	( )
____	( )

20. Supplementary Codes 69-78
____( )
____( )
____( )
____( )
____( )

Ozone Effects Study

GEOMET, Incorporated
Sept. 1975

INTERVIEW RECORDING FORM

Interviewer ____________________

Study # 9-________ E.R. Log # ________ Hosp. # ________ Date E.R. Visit ________

Call Record:	1	2	3	4	5	6	7	8
Date of Try	____	____	____	____	____	____	____	____
Time of Try	____	____	____	____	____	____	____	____

Notes - First Call ______________________________

- Call Back #1 ______________________________

- Call Back #2 ______________________________

Final Status:

__ Complete

__ Partial

__ Refused

__ Other (Specify)

____

____

Respondent:

__ Patient

__ Mother/Spouse

__ Other

Time for Interview:

______ min.

. . . .

(Cut Along This Line)

Study # 9-________

Patient Name ______________________________ Phone ________________

Street ______________________________ ________________

City/Zip ______________________________ ________________

Additional Information (Relatives, Place of Work, Neighbors, Etc.)

Age ______

Sex ______

(REMOVE NAME SECTION WHEN FINISHED)

FIRST CALL

"Hello, this is ____________ (Name) calling from Riverside General Hospital. Is this the residence of ____________ (Patient)?"

[IF NOT THE CORRECT NUMBER, APOLOGIZE AND HANG UP. IF CORRECT, PROCEED.]

"The Hospital is cooperating in a research study of patients seen in emergency rooms. I'd like to speak with ______________________ (Patient) (Patient's Mother)."

[IF PATIENT OR PRIMARY RESPONDENT IS ABLE TO SPEAK WITH YOU, PROCEED.]
[IF PATIENT HAS DIED, APOLOGIZE AND HANG UP.]
[IF PATIENT OR PRIMARY RESPONDENT IS UNABLE TO SPEAK WITH YOU, SAY:]

"When would be a good time soon for me to call and talk with him(her)? I'll note down a time that would be convenient."

[NOTE THE TIME AND CALL BACK.]

CALL BACK #1

[FOLLOW PROCEDURES FOR FIRST CALL. IF PATIENT OR PRIMARY RESPONDENT IS STILL UNABLE TO SPEAK WITH YOU, ASK:]

"Well then, may I speak with some other adult who knows about ____________ (Patient's) health and background?"

[WHEN KNOWLEDGEABLE PERSON COMES TO PHONE, EXPLAIN AND PROCEED. IF THERE IS NO KNOWLEDGEABLE ADULT TO SPEAK WITH YOU, ASK:]

"When would be a good time soon for me to call and talk with someone about ____________ (Patient)? I'll note down a time that would be convenient."

[NOTE THE TIME AND CALL BACK.]

CALL BACK #2

[FOLLOW ABOVE PROCEDURES TO TRY TO TALK TO PATIENT, PRIMARY OR SECONDARY RESPONDENT. IF NONE AVAILABLE, TERMINATE ATTEMPTS.]

"First, I'd like to get some background information."

1. "Thinking back to _________, before you (he/she) came to the emergency room, what were you (was he/she) doing most of the time: working, keeping house, going to school, or something else?"	1.	(0) ____	Don't know ⑫
		(1) ____	Working or combination ③
		(2) ____	Keeping house ⑫
		(3) ____	Going to school ⑨
		(4) ____	Something else ②
2. "Which best describes your (his/her) situation at that time: retired, on vacation, looking for work, not looking for work, or none of these?"	2.	(0) ____	Don't know ⑫
		(1) ____	Retired
		(2) ____	Vacation
		(3) ____	Looking for work
		(4) ____	Not looking for work
		(5) ____	None of these
3. "On the job were you (was he/she) regularly exposed (at least weekly) to very cold or very hot temperatures, or such things as dust, smoke, chemical fumes or sprays?"	3.	(0) ____	Don't know
		(1) ____	No, none regularly
		(2) ____	Yes; cold or heat
		(3) ____	Yes; dust, smoke, chemicals
4. "Did you (he/she) work during the daytime or during the evening or night?"	4.	(0) ____	Don't know
		(1) ____	Daytime
		(2) ____	Evening, night
5. "Did you (he/she) work in ________________ (Town of Residence) or some other town?"	5.	(0) ____	Don't know
		(1) ____	In Metro area
[IF NOT, ASK:] "Where did you (he/she) work?" (Town) ____________________.		(2) ____	Outside Metro area

6. "About how much time did you (he/she) spend altogether getting to and from work? ● Less than 30 minutes? ● 30 minutes to an hour? ● 1 to 2 hours? ● More than 2 hours?"	6. (0) ____ Don't know (1) ____ Less than 30 minutes (2) ____ 30 minutes to an hour (3) ____ 1 to 2 hours (4) ____ More than 2 hours
7. "Did you (he/she) spend most of your (his/her) work hours inside, riding in a car or truck, or working outdoors?"	7. (0) ____ Don't know ⑫ (1) ____ Inside ⑧ (2) ____ Riding in vehicle ⑫ (3) ____ Outdoors ⑫ (4) ____ Combination inside/outside ⑧
8. "Did you (he/she) work mostly in an air conditioned building?"	8. (0) ____ Don't know (1) ____ Yes (2) ____ No (3) ____ Sometimes in air conditioning ⑫
9. "Was the school in ____________ or some other town?" [IF NOT, ASK:] "What town?" ____________	9. (0) ____ Don't know (1) ____ Metro area (2) ____ Outside Metro area
10. "Were the classrooms air conditioned?"	10. (0) ____ Don't know (1) ____ Yes (2) ____ No (3) ____ Some classrooms

11. "Did you (he/she) go to school during the daytime or during the evening?"	11. (0) ____ Don't know (1) ____ Daytime (2) ____ Evening
12. "During the time before you (he/she) came to the emergency room, that is during ________ (Months) and before, were you (was he/she) limited in the kind or amount of physical activity you (he/she) could do because of a health problem?" [IF YES, ASK:] "Had this health condition lasted less than 3 months or more than 3 months?"	12. (0) ____ Don't know ⑯ (1) ____ No, not limited ⑯ (2) ____ Yes, less than 3 months ⑬ (3) ____ Yes, nore than 3 months ⑬
13. "Which of these best described your (his/her) limitations at this time from this health problem?" • Could move around inside and outdoors with no help, crutches, canes, or wheelchair? • Needed help, crutches, cane, or wheelchair to get around but frequently went outdoors? • Confined to the house all or most of the time because of health? • Confined to bed all or most of the day because of health?	13. (0) ____ Don't know (1) ____ No assistance (2) ____ Outdoors, with assistance (3) ____ Confined to house (4) ____ Confined to bed

14. "Did your (his/her) health problems include any of the following conditions? (Please answer Yes or No)
   - a. Asthma?
   - b. Bronchitis, emphysema or lung disease?
   - c. Heart trouble, stroke or high blood pressure?
   - d. Diabetes?
   - e. Ulcers or stomach trouble?
   - f. Liver trouble?
   - g. Epilepsy or some kind of seizures?
   - h. Kidney trouble?
   - i. Arthritis or problems with muscles, limbs or joints?

15. [IF ALL NO, ASK:] "Could you tell me what the health problem was?" ______________________

16. "Now could you tell me what kind of symptoms or illness caused you (him/her) to come to the emergency room?" ______________________
____

17. "About how long before the visit had you (he/she) been sick or had these symptoms?
   - a. A few hours or less?
   - b. A day?
   - c. 2 or 3 days?
   - d. 3 days to a week?
   - e. More than a week?

14.

	Don't know	Yes	No ⑮
a.	____	____	____
b.	____	____	____
c.	____	____	____
d.	____	____	____
e.	____	____	____
f.	____	____	____
g.	____	____	____
h.	____	____	____
i.	____	____	____

15. (   )

16. (,   ,   ,   )

17.
(0) ____ Don't know ⑱
(1) ____ Few hours ⑳
(2) ____ A day ⑳
(3) ____ 2 to 3 days ⑱
(4) ____ 3 to 7 days ⑱
(5) ____ More than 7 days ⑱

18. "Before you (he/she) came to the emergency room did these symptoms prevent you (him/her) from doing the things you normally do (he/she normally does) during the day, or were you (was he/she) about as active as usual?" [IF YES, ASK:] "Did the symptoms cause you (him/her) to stay in bed during any of the days before you (he/she) came to the emergency room?"	18. (0) ____ Don't know (1) ____ Normal activity (2) ____ Reduced activity (3) ____ Stayed in bed
19. "On the day of the emergency room visit, was your (his/her) condition getting worse, getting better, or about the same as the day before?"	19. (0) ____ Don't know (1) ____ Worse (2) ____ Better (3) ____ Same
20. "Were you (was he/she) admitted to the hospital that day?" [IF NO, ASK:] "Were you (was he/she) admitted to a hospital later that week?"	20. (0) ____ Don't know (1) ____ Not admitted at any time (2) ____ Admitted same day (3) ____ Admitted later
21. "Was this the first time you (he/she) had seen a doctor this year for this condition?" [IF NO, ASK:] "About how many times in the 12 months before this had you (he/she) seen a doctor for this problem?"	21. (0) ____ Don't know (1) ____ Yes, first time (2) ____ No, 2 or 3 times (3) ____ No, more than 3 times

22.	"Thinking back again to the day you (he/she) started to get sick or started to have the symptoms you mentioned, were you in ____________ (Town of Residence) or somewhere else?" [IF NOT, ASK:] "Where was this?" ____________	22.	(0) ____ Don't know (1) ____ In Metro area (2) ____ Outside Metro area
23.	"On that day or the day before did you (he/she) spend more than 2 to 3 hours at one time outdoors or in a car or truck?"	23.	(0) ____ Don't know (1) ____ Not outside (2) ____ Outdoors (3) ____ In car or truck
24.	[IF OUTDOORS] "While you were (he/she was) outdoors, were you (was he/she) doing anything more active than sitting or walking? That is were you (was he/she) doing anything that caused you (he/she) to perspire a lot or breath harder than usual?"	24.	(0) ____ Don't know (1) ____ No, normal activity (2) ____ Yes, heavy activity
	"Now, I'd like to finish with a few general questions."		
25.	"About how long have you (has he/she) lived in ____________ (Town of Residence) and in towns around Riverside?"	25.	( )
26.	"Is your (his/her) present residence air conditioned?"	26.	(0) ____ Don't know (1) ____ Yes (2) ____ No (3) ____ Partially

27. "Would you please tell me which category best describes your (his/her) annual family income?" o Under $5,000? o $5,000 to $10,000? o $10,000 to $15,000? o Over $15,000?	27. ____ Don't know ____ Under $5,000 ____ $5,000 to $10,000 ____ $10,000 to $15,000 ____ Over $15,000
28. "Finally, could you explain why you (he/she) came to the Riverside General emergency room instead of some other doctor or clinic?" ____________________ ____________________ ____________________	28. ( )

"Thank you very much for your help."

PILOT STUDY - GENERAL DATA COLLECTION INSTRUCTIONS

1.0 INTRODUCTION

The purpose of GEOMET's research in Riverside is to develop improved methods for determining the relationship of human illness to ozone and other air pollutants. These methods involve data obtained on patients who visit hospital emergency rooms. The data will be collected from medical records and through a telephone interview.

Development of these methods will be done in several stages. Initial versions of the data collection forms and procedures will first be used in a short pilot test; then, later in 1975, a more extensive field trial is anticipated. Our aim is to construct fairly precise and efficient measures of the patient's course of illness, his sensitivity to major harmful chemicals in the air, and his exposure to pollutants.

Instructions and forms for the first, pilot test are contained in this package. In particular, the package includes:

- How the sample of patients is to be chosen
- Use of information in the emergency room log
- Instructions for medical record abstracts
- Instructions for the interview
- Guidelines for good telephone interviewing
- Abstracts and interview forms.

Because this is a test, there may be changes made by the Project Director from time to time in an attempt to identify better procedures. Also, it is important that the field staff pay close attention to the process so that we may learn what works, what is deficient, and why. Discussions should be held by telephone with the Project Director every few days on the abstracting and interviewing process.

2.0 GENERAL PROCEDURES

The general sequence of steps that should be followed, and the responsible person, are listed below. (Responsible person is either medical record abstractor (M) or interviewer (I).

1) Make xerox copies of the emergency room log for designated time periods. (M)
2) Identify patients in the log with certain diagnoses or complaints. (M)
3) Select patient abstract sample and assign study number. (M)
4) Complete record abstract on total sample and interview cover sheets on interview sub-sample. (M)
5) Code record abstract. (M)
6) Conduct patient interview. (I)
7) Code identified diagnoses and complaints on log sheets. (M)
8) Forward completed material to GEOMET weekly.

While we can provide general instructions, the abstractor and interviewer will have to work out efficient day-to-day procedures together.

3.0 SAMPLE SELECTION

3.1 Emergency Room Log Sample

The emergency room log will provide the basic source of patients and serve as a master list. The first step is to make copies of the log sheets for the following periods:

August 25-31, 1975
June 24-30, 1975
April 24-30, 1975
February 22-28, 1975
December 25-31, 1974
October 25-31, 1974

Treat the 7 days for each month as a group.

In step two, starting with August 1975 identify all patients having a diagnosis or a complaint on the list shown. Do this in the following manner:

1) If a patient has one of the diagnoses on the list, make a checkmark by the log number.

2) If no definite diagnosis has been recorded, but only the complaint, check those patients with any of the symptoms shown on the list.

Examples:

Fever, chills	URI	(✓)
Fever, chills	UTI	(exclude)
Fever, chills	-	(✓)
Depression	-	(✓)
O.D. on alcohol	-	(exclude)
Gastritis	Hx alcoholism	(exclude)
Stomach pain	Anxiety	(✓)

In other words, the diagnosis takes priority and patient complaints of the type listed are included only if there is no diagnosis which shows the patient has a condition which is not on our list of diagnoses. When in doubt, include that patient.

3.2 Selecting the Abstract Sample

For step three, after the screening, start with the first day and the first patient checked and assign a study number to every fifth patient until you have selected 50 patients from that week. There are two restrictions:

1) After you have assigned numbers to the first 10 URI patients skip the rest with this diagnosis.

2) After you have assigned numbers to the first 5 gastroenteritis patients, skip the rest with this diagnosis.

When finished you should have 10 URI's, 5 gastroenteritis and the rest with other diagnoses or complaints.

For step four, complete the record abstracting for that period before you go onto the other weeks.

3.3 Selecting the Interview Sample

As you abstract records, fill out an interview cover sheet on every second case. That is, every other patient in the abstract sample will also be in the interview sample. (Completion of the interview cover sheet is described in the Patient Interview Instructions.)

3.4 Further Steps

After completing the abstracts for the first week, make copies for the next period and repeat the process above. HOWEVER, select interviews for August, June, April and February only, not the last two weeks.

4.0 LOG SHEET CODING

For each patient checked on the log (not just those with study numbers), code the complaint and diagnosis separately. Use the symptom code (NCHS) for complaints and the H-ICDA (2nd edition) for diagnoses (just as on the record abstract).

Fit this task in as you can. Priority should be given to preparing the abstracts and interview cover sheets so that the interviewer won't have to wait on cases.

When coding is complete remove the patient's name from the log sheets and forward them to GEOMET. You can either mark over the name with a black, opaque brush pen or cut the names out and paste the two halves of the sheet back together.

Since these log sheets will also serve as a master patient list, check off each patient as the abstract and interview are completed. Don't send any sheets in until you have completed the forms for all the patients on that sheet in the samples.

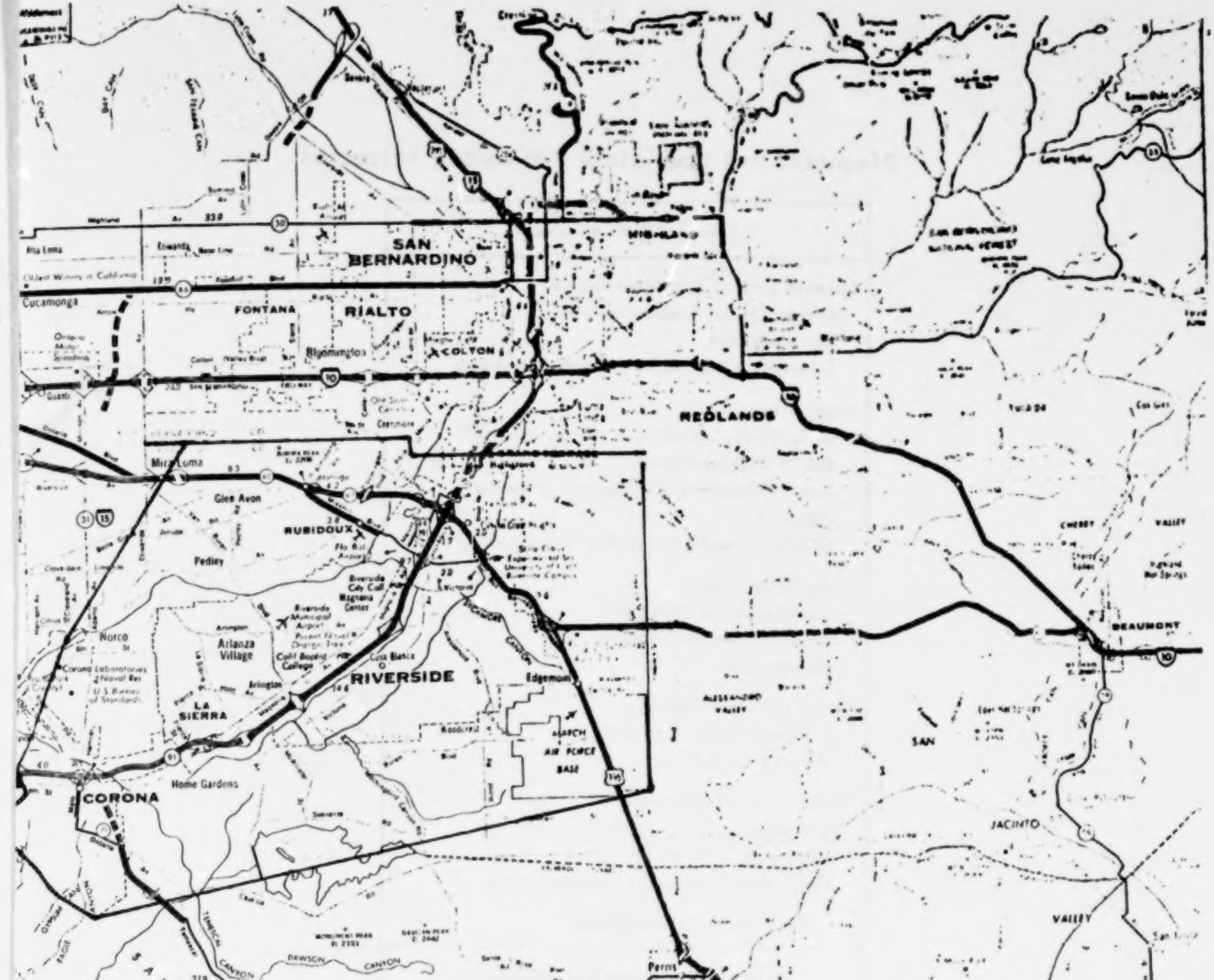
5.0 STUDY NUMBERS

All patients in the pilot test will be assigned to a study number beginning with 9001. Start with the first patients selected for the abstract sample and assign study numbers in sequence.

Boundaries of Metro Area (Riverside County only)*

- Highgrove
- Sunnymead
- March AF Base
- Corona
- Norco
- Mira Loma
- Glen Avon
- Sunnyslope

* Only patients that reside within Riverside metropolitan toll-free telephone area will be included, plus patients from Corona.


SAN BERNARDINO
HIGHLAND
Cucamonga
FONTANA
RIALTO
Bloomington
COLTON
REDLANDS
Mira Loma
Glen Avon
RUBIDOUX
Pedley
Norco
Arlanza Village
RIVERSIDE
LA SIERRA
Edgemont
MARCH AIR FORCE BASE
CORONA
Home Gardens
BEAUMONT
SAN
JACINTO
VALLEY
Perris
STEELE VALLEY
Temescal
SANTA ANA MTS
Alberhill
Lake Elsinore
Lakeland Village
CLEVELAND NATIONAL FOREST
DIAMOND VALLEY
PALOMA VALLEY
LOS ALAMOS VALLEY
Hemet
TEMESCAL CANYON
DAWSON CANYON
CANYON
San Juan Hot Springs
Glen Ivy Hot Springs
Trabuco Oaks
Mission Viejo
10
15
30
60
71
74
91
215

Diagnoses and Complaints for Sample Selection

Selected E.R. Diagnoses

- Nervous System and Sense Organs
  - Eye Irritation, Conjunctivitis
  - Otitis Media*
  - Convulsive Disorders, Idiopathic Seizures
- Respiratory System
  - URI, Colds, Tonsillitis, Sinus, Allergy
  - Flu, Viral Syndrome*
  - Acute Bronchitis, Pneumonia, Pleurisy*
  - Asthma*
  - COPD, Chronic Bronchitis, Emphysema*
- Circulatory System
  - Cardiovascular Disorders
  - Cerebrovascular Disorders
  - Hypertension
- Gastrointestinal System
  - Gastroenteritis, Gastritis
  - Ulcers (Upper G-I)
- Other Selected Diagnoses
  - Diabetes
  - Hepatitis, Hepatic Disorders
  - Psychiatric Disorders (Excluding O.D.)

Total Selected Diagnoses

Selected Symptoms Not Included in Above Diagnoses

- Chills, Fever
- Fatigue, Weakness, Fainting, Dizzy
- Dehydration, Fluid Inbalance
- Coma, Stuper, Unconciousness
- Headache
- Convulsions, Seizures
- SOB, Breathing Difficulty, Hyperventilation
- Chest Pain, Congestion, Cough
- Sore Throat
- Abdominal Pain, Cramps
- Diarrhea, Nausea, Vomiting
- Jaundice
- Depression, Nerves, Abnormal Behavior
- Epistaxis w/o Injury

Total Selected Symptoms

* With or Without URI.

OZONE EFFECTS STUDY

PATIENT RECORD ABSTRACT AND CODING MANUAL

General Instructions

This manual contains the form, instructions and procedures for completing an abstract of the patient's medical record. The information to be obtained is for specific patients, and is restricted to medical condition and medical care received during specific emergency room visits. (See Sample Selection Instructions for procedures to choose patients and visits.)

The patient Record Abstract will be completed in four steps:

1) Enter Case No., Log No., and Hospital No., from Master Patient List.

2) Obtain medical record and enter the information called for in this manual. Leave the section or item blank if the information is not available in the patient's record.

3) Complete coding of each item using the supplementary coding schedules in this manual.

4) Review form for completeness and accuracy. Then enter initials and date in lower left corner of the form.

A notation should be made on the master list as the abstracts are completed. Completed abstracts should be kept in a separate folder, filed in case number order, and forwarded routinely in batches to GEOMET.

Exceptions. Situations will occur which are not covered by the instructions. Do not make arbitrary decisions. If there are frequent exceptions, call the GEOMET Project Officer for instructions. If there are only occasional exceptions, review these cases on the next site visit.

PATIENT RECORD ABSTRACT CODING

Section	Item		Card Field	
1	Case No.		(Card 1)	
	Enter case number assigned for this study.		1-4	XXXX
2	Log No.			
	Enter emergency department log number.		5-7	XXX
3	Hospital No.			
	Enter hospital patient record number.		8-13	XXXXXX
4	E.D. Arrival			
	Date:	Enter month and day patient was seen in emergency department (e.g. 06/19 is June 19)	14-17	XXXX
	Day:	Enter code for day of the week (1) Mon. (3) Wed. (5) Fri. (7) Sun. (2) Tues. (4) Thurs. (6) Sat.	18	X
	Time:	Enter time that patient arrival was logged, using 24-hour clock. (e.g., 1315 is 1:15 P.M.)	19-22	XXXX
	By:	Check (✓) whether patient arrived by ambulance or by other means.	23	X
5	Sex			
	Check Male (M) or Female (F)		24	X
6	Ethnic Group			
	Check appropriate ethnic group		25	X
	W- White B- Black	M- Mexican O- Other groups		

Section	Item		Card Field	
7	Age.			
	Enter ages as completed days, months or years according to following groups. Circle d, m or y to indicate meaning of value. 1-28 days as # days (29-31 days = 1 m) 1-11 months as # months (12-23 months = 1 y) 1-99 years as # years (100+ years = 99 y)		26-28	XXX
8	Married.			
	Check yes (Y) if record indicates patient is currently married. Otherwise check no (N)		29	X
9	Residence.			
	Enter name of city patient gave as current permanent residence. Select appropriate location code from Schedule A and enter in parentheses.		30-31	XX
10	Payment			
	Check expected method of payment shown in record. I- Insurance W- MediCal Welfare M- Medicare O- Cash payment and all other third party.		32	X
11	Complaints.			
	Symptom:	Enter name of each symptom or problem patient gives as presenting complaint (even if more than five). Enter NCHS code (Schedule B) in parentheses for first five symptoms listed.	33-36 40-43 47-50 54-57 61-64	XXXX XXXX XXXX XXXX XXXX
	Onset:	Enter approximate duration corresponding to each symptom from time patient first noticed onset, according to following groups. Circle h or d. 1-23 hours (h) as # hours 1+ days (d) as # days	37-39 44-46 51-53 58-60 65-67	XXX XXX XXX XXX XXX

Section	Item		Card	Field
12	Condition.			
	Check indication of patient's condition when seen (if noted in record), according to following.		68	X
	Alert: Alert, conscious, normal behavior Agitated: Agitated, hysterical, violent, required restraints, behavior problem. Disoriented: Disoriented, confused, semi-conscious, faint. Unconscious: Unconscious, comatose, passed out in E.R.			
13	Vital Signs.			
	Enter value for each vital sign recorded when first seen. Enter 0 if not recorded. Then enter code (Schedule C) for appropriate group in parentheses.			
	Temperature : e.g. 99.6 (Farenheit)		69	X
	Pulse : Rate per minute		70	X
	Respiration : Rate per minute		71	X
	Blood Pressure: Enter systolic on first line		72	X
	and diastolic on line below.		73	X
14	Medical History			
	Check any of the following conditions that	#1	74	X
	are mentioned on this visit as part of the	#2	75	X
	patient's medical history. (KP: enter code	#3	76	X
	for first 6)	#4	77	X
	Asthma (any type)	#5	78	X
	COPD (Chronic obstructive pulmonary disease, chronic bronchitis emphysema)	#6	79	X
	Heart Disease (any type)			
	Hypertension (including abnormal high blood pressure)			
	Stroke (cerebrovascular accident, CVA)			
	Diabetes (any type)			
	Chronic Gastro-Intestional Disease (ulcers, chronic gastritis only)			
	Liver Disease (cirrhosis, hepatitis)			

Section	Item	Card Field	
14	Renal Disease (chronic nephritis, chronic nephrosis, renal failure)		
	(Enter 1 in cc 80)	80	X
		(Card 2)	
	(Repeat Case No. in cc 1-4, card 2)	1-4	XXXX
15	Diagnostic Data		
	Enter values for any of the lab tests shown that were ordered by the E.R. physician.		
	For total protein, albumin and globulin check whether speciman was blood (B) or urine (U).		
	For chest film and ECG, check positive if any abnormality mentioned in notes.		
	Then enter code (Schedule D) for individual lab tests and for summary of blood gas findings in appropriate parentheses.		
	Hgb. (Hemoglobin)	5	X
	WBC (White blood cell count in thousands, e.g. 10,500 as 10.5)	6	X
	Lymphs (% of total to nearest decimal, e.g. 45.4%)	7	X
	Eos (% of total to nearest decimal, e.g. 4.5%)	8	X
	SGOT	9	X
	Total Protein	10	X
	Albumin	11	X
	Globulin	12	X
	Blood or Urine	13	X
	Chest film	14	X
	ECG	15	X
	Blood Gases (summary code)	16	X
	Na (Sodium)	17	X
	K (Potassium)	18	X
	Cl (Chloride)	19	X
	HCO_3 (Bicarbonate)	20	X

Section	Item		Card Field	
16	Treatment.			
	Check any of the following procedures that were done on this visit. Enter 1 in parentheses for each checked, 0 for others.			
	Injections (any)		21	X
	I.V. Fluids (any, including blood products)		22	X
	IPPB		23	X
	O_2 (Oxygen, by mask or N-T tube)		24	X
	CPR (resuscitation after cardiac or pulmonary arrest)		25	X
17	E.D. Diagnoses			
	Enter name of each final E.R. diagnosis recorded (even if more than five). Enter code (H-ICDA, 2nd edition) for the the first five diagnoses in parentheses.	#1	26-29	XXXX
		#2	30-33	XXXX
		#3	34-37	XXXX
		#4	38-41	XXXX
		#5	42-45	XXXX
18	E.D. Disposition			
	Check category describing disposition from the emergency department.		46	X
	Home (Patient's or other residence)			
	ECF (extended care facility, ICF,SNF, nursing home)			
	Hosp. (VA, mental, tuberculosis or other long-term care hospital)			
	ICU (ICU, CCU or any intensive care unit of this hospital)			
	O.R. (admit direct to operating room or recovery room for treatment)			
	Other (any hospital bed unit other than ICU or O.R.)			
	Transfer (Acute) (transfer to another hospital for acute, short-term care)			
	Died in E.D. (died after E.R. arrival, DOA's should not be abstracted)			
19	Admission Data.			
	For patients admitted to this hospital from the emergency room, enter length of stay in days and name of final hospital discharge diagnoses (even if more than five). Enter code (H-ICDA, 2nd edition) for the first five diagnoses in parentheses.			

Section	Item		Card Field	
19	LOS (Length of stay): Enter total of complete and partial days from admission to discharge		47-48	XX
	Disch Dx (Discharge Diagnoses)	#1	49-52	XXXX
		#2	53-56	XXXX
		#3	57-60	XXXX
		#4	61-64	XXXX
		#5	65-68	XXXX
20	Supplemental Codes.			
	Reserved for additional items or summary codes.	#1	69-70	XX
		#2	71-72	XX
		#3	73-74	XX
		#4	75-76	XX
		#5	77-78	XX
	(Enter 2 in cc 80)		80	X

END

SPECIAL CODE SCHEDULES

The following code schedules are to be used for those sections and items that are not precoded. The codes selected are to be entered in the parentheses provided. They are not to be used in place of a data item called for. The schedules are:

Schedule A: Location Codes (Section 9)

B: Symptom Codes (Section 11)

C: Vital Signs Codes (Section 13)

D: Diagnostic Data Codes (Section 15)

In addition, manuals for the Hospital Adaptation of ICDA (H-ICDA, 2nd edition) will be used to code diagnoses in Sections 17 and 19.

Schedule A

Location Codes

(to be developed when geographic grid defined)

Schedule B

Symptom Codes (NCHS)

The four-digit codes listed in the following pages will be used to code each symptom listed in Section 11. They are taken from DHEW Publication No. (HRA) 74-1337, "The National Ambulatory Medical Care Survey: Symptom Classification." A decimal code has been added for certain specific terms under the general heading.

For most symptoms the proper code will be readily found. Use the index to verify coding decisions and to determine the proper code when it is not obvious.

SYMPTOM CODES

ALPHABETIC INDEX OF TERMS

Abdominal
    distension 542.0
    fullness 542.0
    pain 540.0
    rigidity 542.0
    swelling 542.0
Abnormal Abnormality
    breathing sounds 307.0
    drug usage 822.0
    ear size 739.0
    eye appearance 717.0
    gait 421.0
    hair 124.0
    heart sounds 200.0
    high blood pressure 205.0
    lip color 505.0
    low blood pressure 206.0
    periods 653.0
    protrusion (eye) 717.0
    retraction (eye) 708.0
    secretion (postpartum, breast) 684.0
    sounds (respiratory) 307.0
    stools 556.0
    tongue color 525.0
Abnormal involuntary movements 050.0
    eyes 708.0
    muscles (*see also* Twitching) 050.0
Abortion
    counseling 930.0
    performed 932.0
    request 930.0
Absence (*see also* Lack of)
    appetite 545.0
    feeling 059.0
    hair 124.0
    milk (postpartum) 684.0
Ache
    all over 013.0
    ankle 400.0

Ache–Con.

    arm 405.0
    back 415.0
    back of head 410.0
    cervical spine 410.0
    elbow 405.0
    face 410.0
    fingers 405.0
    foot 400.0
    forearm 405.0
    generalized 013.0
    hand 405.0
    hip 400.0
    jaw 410.0
    joints, not specified 425.0
    knee 400.0
    leg 400.0
    limbs, not specified 425.0
    lower back 415.0
    lower extremity, part unspecified 400.0
    lumbar 415.0
    lumbosacral 415.0
    neck 410.0
    sacroiliac 415.0
    shoulder 405.0
    site unspecified 013.0
    spine 415.0
    thigh 400.0
    thoracic spine 415.0
    thumb 405.0
    toe 400.0
    upper back 415.0
    upper extremity, part unspecified 405.0
    upper spine 415.0
    wrist 405.0
Acne 100.0
Activity
    over 805.0

- Activity–Con.
  - over (infants) 020.0
  - under (infants) 020.0
- Acute hearing 731.0
- Alcohol-related disturbances 821.0
- Allergic skin reactions 112.0
- Allergy shots 910.0
- Amnesia 058.0
- Anesthesia 059.0
- Ankle
  - ache 400.0
  - broken 400.0
  - cold 400.0
  - contracture 400.0
  - cramp 400.0
  - hot 400.0
  - hurt 400.0
  - injury 400.0
  - limited motion 400.0
  - pain 400.0
  - pulled muscle 400.0
  - soreness 400.0
  - spasm 400.0
  - stiffness 400.0
  - strain 400.0
  - swelling 400.0
- Annual checkup 900.0
- Antisocial behavior 815.0
- Anus, symptoms referable to 560.0
- Anxiety 800.0
- Appetite
  - abnormal 545.0
  - decreased 545.0
  - excessive 545.0
  - loss of 545.0
- Apprehension 800.0
- Arm
  - ache 405.0
  - broken 405.0
  - cold 405.0
  - contracture 405.0
  - cramp 405.0
  - hot 405.0
  - hurt 405.0
  - injury 405.0
  - limited motion 405.0
  - pain 405.0
  - pulled muscle 405.0
  - soreness 405.0
  - spasm 405.0
  - stiffness 405.0
- Arm–Con.
  - strain 405.0
  - swelling 405.0
- Ashen color 212.0
- Athlete's foot 106.0
- Atrophy of extremities 420.0

- Back, lower upper
  - ache 415.0
  - contracture 415.0
  - cramp 415.0
  - hurt 415.0
  - injury 415.0
  - limited motion 415.0
  - pain 415.0
  - pulled muscle 415.0
  - soreness 415.0
  - spasm 415.0
  - stiffness 415.0
  - strain 415.0
  - swelling 415.0
- Bad
  - breath 502.0
  - complexion 100.0
  - habits 826.0
  - heart 216.0
  - taste 510.0
- Balance, loss of sense of 069.0
- Baldness 124.0
- Bedwetting 601.0
- Behavioral disturbances 815.0
- Belching 570.0
- Biliary
  - colic 580.0
  - symptoms of 580.0
- Bites 116.0
- Bitterness 807.0
- Black-
  - eye 716.0
  - heads 100.0
  - out 214.0
- Bladder problems (*see* 600.0-606.0)
- Bleed, Bleeding
  - ear 734.0
  - eye 704.0
  - gastrointestinal 550.0
  - gingival 501.0
  - gums 501.0
  - lips 505.0
  - nose 300.0
  - from rectum 550.0

Bleed, Bleeding–Con.
    of rectum 560.0
    tongue 525.0
    tonsils 527.0
Blemishes 100.0
Blindness, partial or complete 700.0
Blind spots 701.0
Blisters
    nonallergic 116.0
    tongue 525.0
Bloating, gas 543.0
Blocked feeling in ears 737.0
Blood
    in stools 550.0
    poor 210.0
    tired 210.0
    vomiting 550.0
    weak 210.0
Blood pressure
    abnormal 205.0
    decreased 206.0
    elevated 205.0
    high 205.0
    low 206.0
Bloodshot eyes 717.0
Blueness
    fingers 212.0
    toes 212.0
Blurred vision 701.0
Blushing
    abnormal 104.0
    excessive 104.0
Boils 106.0
Bowel, Bowels
    change in 556.0
    dysfunction 556.0
Breaking nails 122.0
Breaking out 100.0
Breast
    bump 680.0
    deformity 690.0
    hard spot 680.0
    knot 680.0
    lump 680.0
    mass 680.0
    nodule 680.0
    pain 681.0
    redness 681.0
    sagging 690.0
    soreness 681.0
    swelling 680.0
Breast, swelling–Con.
        generalized 681.0
        local 680.0
    tender 681.0
    too large 690.0
    too small 690.0
Breath, breathing
    bad 502.0
    problem 307.0
    shortness of 306.0
    sounds, abnormal 307.0
Breathlessness 306.0
Brittle
    hair 124.0
    nails 122.0
Bruises 116.0
Bulge (*see* Swelling and particular site)
Bump (*see* Swelling and particular site)
Bunion 429.0
Burning
    eye 705.0
    sensation (in chest) 322.0
    skin 113.0
    tongue 525.0
    urination 604.0
Burns
    chemical 116.0
    mouth 050.0
    steam 116.0
    sun 116.0
    wind 116.0
Butterflies 810.0
Buzzing in ear 731.0
Calluses 108.0
Change in
    bowels 556.0
    voice 325.0
Charleyhorse 400.0
Chest
    congestion in 321.0
    pain in 322.0
    pressure in 322.0
    tightness 322.0
Chewing
    difficulties 500.0
    on hair 826.0
Chills 001.0
Choking 528.0
Clammy skin 120.0
Cloudy
    eye appearance 717.0
    vision 701.0

Clumsiness 421.0
Coated tongue 525.0
Coitus, painful 661.0
Cold 312.0
Cold
  ankle 400.0
  arm 405.0
  elbow 405.0
  fingers 405.0
  foot 400.0
  forearm 405.0
  hand 405.0
  hip 400.0
  knee 400.0
  leg 400.0
  lower extremity, part unspecified 400.0
  shoulder 405.0
  skin 120.0
  thigh 400.0
  thumb 405.0
  toe 400.0
  upper arm 405.0
  upper extremity, part unspecified 405.0
  wrist 405.0
Colic
  biliary 580.0
  infantile 541.0
  intestinal 540.0
  NOS 540.0
Collapse 214.0
Color
  ashen 212.0
  change in nail 122.0
  change in nipple 683.0
  change in skin 104.0
Coma 052.0
Compulsion 827.0
Conflict
  job 941.0
  marital 941.0
Confusion 053.0
Congestion
  chest 321.0
  nasal 301.0
  sinus 304.0
Conjunctivitis 712.0
Constipation 554.0
Contraceptive counseling 930.0
Contracture (*see* Ache and particular site)
Convulsions 054.0
Corns 108.0
Cough, coughing 311.0
  phlegm 320.0
  sputum 320.0
Cracked
  lips 505.0
  nails 122.0
  skin 120.0
Cramps (*see also* Ache and particular site)
  menstrual 652.0
  stomach 540.0
Cross-eyed 708.0
Croup 314.0
Crying 807.0
  infants 020.0
Cuts 116.0
Cyst
  site unspecified 015.0
  skin 115.0

Dark urine 600.0
Deafness 730.0
Decreased
  appetite 545.0
  blood pressure 206.0
  pulse 200.0
Deformity
  breast 690.0
  ears 757.0
Dehydration 007.0
Dejected 807.0
Delusion 824.0
Depression 807.0
Diaper rash 112.0
Diarrhea, functional 555.0
Diet control
  change 940.0
  counseling 940.0
Difficulty
  breathing 306.0
  chewing 500.0
  nursing 684.0
  swallowing 528.0
  walking 421.0
Diminished
  hearing 731.0
  vision 701.0
Discharge
  ear 734.0
  eye 704.0
  nipple 683.0
  tonsils 527.0

Discharge--Con.
  umbilicus 126.0
  vaginal 662.0
Discoloration
  nails 122.0
  skin, 104.0
Discontented 807.0
Disorders (*see also* Disturbance)
  respiratory rhythm 307.0
  respiratory sound 307.0
  urinary 610.0
  voice 325.0
Dissatisfaction, job 941.0
Distention
  abdominal 542.0
  bladder 603.0
  gas 543.0
Disturbance (*see also* Disorder)
  hearing 731.0
  memory 058.0
  sensation 059.0
  sleep 062.0
  smell 059.0
  taste 059.0
  touch 059.0
  vision 701.0
Divorce proceedings 941.0
Dizziness 069.0
Draining, umbilicus 126.0
Dribbling 602.0
Drinking problem 821.0
Drip, postnasal 301.0
Drippy nose 301.0
Drooling, excessive 511.0
Drooping eyelid 710.0
Drop, dropping
  foot 422.0
  sensation of pelvic floor 660.0
  wrist 422.0
Dropsy 231.0
Dryness
  eye 705.0
  hair 124.0
  lips 505.0
  mouth 510.0
  nose 330.0
  skin 120.0
Dull
  eye appearance 717.0
  vision 701.0
Dysfunction (*see* Disorders, Disturbance)
Ear
  abnormal size 739.0
  blocked feeling 737.0
  buzzing in 731.0
  discharge 734.0
  extraneous noises 731.0
  pain 735.0
  pierced 960.0
  plugged feeling 737.0
  pressure 737.0
  ringing 731.0
  unusual sounds 731.0
  wax, excessive 738.0
Earache 735.0
Edema 231.0
EKG 920.0
Elbow (*see* Arm and particular condition)
Elevated blood pressure 205.0
Empty
  bladder, inability to 603.0
Engorged nipple 683.0
Enlarged
  heart 220.0
  liver 580.0
  lymph nodes 232.0
  spleen 240.0
Epigastrium pain 540.0
Epitaxis 300.0
Equilibrium, loss of sense of 069.0
Erection, painful 621.0
Excessive
  appetite 545.0
  crying 807.0
  crying (infantile) 020.0
  drinking (alcohol) 821.0
  drooling 511.0
  hair 124.0
  menstrual flow 653.0
  milk secretion 684.0
  phlegm 320.0
  smoking 820.0
  sputum 320.0
  sweating 007.0
  thirst 007.0
  use of stimulants or depressants 822.0
  wax in ear 738.0
Exhausted 004.0
Extremities
  atrophy 420.0
  numbness 420.0
  paralysis 420.0

- Extremities–Con.
  - wasting, 420.0
  - weakness, 420.0
- Eye
  - discharge 704.0
  - dryness 705.0
  - examination 909.0
  - inflamed 705.0
  - injuries 716.0
  - itching 705.0
  - pain 705.0
  - protrusion 717.0
  - red 717.0
  - swelling 705.0
  - tearing 704.0
  - watering 704.0
- Eyelid
  - closed 710.0
  - drooping 710.0
  - dropping 710.0
  - itching 710.0
  - red 710.0
  - swollen 710.0
  - symptoms of 710.0

- Face
  - ache 410.0
  - contracture 410.0
  - cramp 410.0
  - hurt 410.0
  - injury 410.0
  - limited motion 410.0
  - pain 410.0
  - pulled muscle 410.0
  - soreness 410.0
  - spasm 410.0
  - stiffness 410.0
  - strain 410.0
  - swelling 410.0
- Fainting 214.0
- Falling
  - (out) of hair 124.0
  - (out) of nails 122.0
  - sensation 069.0
  - sensation of pelvic region 660.0
- Family
  - planning 930.0
  - problems 941.0
- Fast
  - breathing 307.0
  - heartbeat 200.0
  - pulse 200.0
- Fatigue 004.0
- Fears 801.0
- Feeding problem 546.0
- Feeling
  - bad 005.0
  - blue 807.0
  - lost 807.0
  - low 807.0
  - numb 059.0
  - rejected 807.0
- Fever 002.0
  - blister 505.0
- Fidgety 805.0
  - infants 020.0
- Fingers (*see also* Arm and particular condition)
  - blueness 212.0
- Fit 054.0
- Flashes
  - hot 650.0
  - light 701.0
- Flatulence 543.0
- Floaters 701.0
- Flu 313.0
- Fluid
  - imbalance 007.0
  - retention 007.0
- Flushing 104.0
- Fluttering heart 200.0
- Followup visit
  - specified condition 980.0
  - unspecified condition 985.0
- Foot (*see also* Ankle and particular condition)
  - drop 422.0
- Forearm (*see* Arm and particular condition)
- Foreign body (*see also* Injury)
  - ear 740.0
  - eye 715.0
- Freckles 104.0
- Frequent
  - menstruation 653.0
  - urination 601.0
- Frigidity 828.0
- Fullness 542.0
  - bladder 603.0
- Functioning, Functional
  - bowels 556.0
  - diarrhea 555.0
- Fussy, infants 020.0

- Gain, gaining weight 010.0
- Gait, abnormal 421.0
- Gallbladder, symptoms of 580.0
  - gallstones 580.0

Gas
  bloating 543.0
  distention 543.0
  excessive 543.0
Gastrointestinal bleeding 550.0
General, generalized
  ill-feeling 005.0
  pain 013.0
  symptoms of infants 020.0
  weakness 004.0
Giddiness 069.0
Gingival bleeding 501.0
Glands, swollen 232.0
Grip 313.0
Groin, pain 540.0
Growth, lack of 009.0
Gums, bleeding 501.0
Gynecologic examination 904.0

Hair
  abnormal 124.0
  dryness 124.0
  excessive 124.0
  loss of 124.0
  symptoms of 124.0
Half-vision 701.0
Halitosis 502.0
Hallucinations 824.0
Hand (*see* Arm and particular condition)
Hard spot (*see* Swelling and particular site)
Hazy
  eye appearance 717.0
  vision 701.0
Head (back of) (*see* Face and particular condition)
Headaches 056.0
Hearing
  disturbance of 701.0
  noises (nonpsychiatric) 701.0
Heart
  beats, irregular 200.0
  burn 570.0
  flutter 200.0
  murmur 201.0
  pain over 322.0
  rapid 200.0
  sounds, abnormal, increased 200.0
  weak 216.0
Hemorrhage
  gastrointestinal 550.0
  nose 300.0
  vaginal 662.0
Hesitancy of urination 610.0
Hiccough 575.0
High
  blood pressure 205.0
  temperature 002.0
Hip (*see* Ankle and particular condition)
Hives 112.0
Hoarseness 325.0
Homosexuality 828.0
Hopelessness 807.0
Hot (*see* Cold and particular site)
Hurt (*see* Ache and particular site)
Hyperactivity 805.0
  infants 020.0
Hyperesthesia 059.0
Hypersomnia 062.0
Hypertension 205.0
Hyperventilation 307.0
Hypotension 206.0

Iliac pain 540.0
Illegible item 999.0
Imbalance, fluid 007.0
Impacted sinuses 304.0
Impending litigation 941.0
Impotence 828.0
Improper lactation 684.0
Inability
  to nurse 684.0
  to stand 421.0
  to urinate 603.0
  to walk 421.0
Incontinence of urine 602.0
Increased
  blood pressure 205.0
  pulse 200.0
Indigestion 570.0
Infantile colic 541.0
Infected sinuses 304.0
Infectious disorders 106.0
Infertility
  counseling 930.0
  female 665.0
  male 620.0
Inflamed, Inflammation
  eye 705.0
  eyelid 710.0
  mouth 510.0
  nipple 683.0
  skin 113.0
  throat 520.0
  tonsils 527.0

Influenza 313.0
Ingrown nail 122.0
Inguinal pain 540.0
Injections of vitamins or hormones 910.0
Injury (*see also* Foreign body and particular site)
  eye 716.0
  nose 116.0
  skin 116.0
Inoculations 910.0
Insertion of IUD 932.0
Insomnia 062.0
Instruction for
  diet change or control 940.0
  exercise 940.0
  regarding imminent surgery 950.0
  use of contraception 931.0
  use of crutches or cane 940.0
Intestinal colic 540.0
Inversion of nipple 683.0
Involuntary
  movements 050.0
  movements of eyes 708.0
  urination 602.0
Irregular
  heartbeats 200.0
  menstruation 653.0
  pulsations 200.0
Irritability 815.0
  infants 020.0
Irritation
  ear 735.0
  eye 705.0
  skin 113.0
Itching
  ear 740.0
  eye 705.0
  eyelid 710.0
  rectum, anus 560.0
  skin 113.0
  vulva 663.0

Jaundice 579.0
Jaw (*see* Face and particular condition)
Job dissatisfaction 941.0
Joint manipulation 960.0
Joints (*see* particular site)
Joints, not specified
  ache 425.0
  contracture 425.0
  cramp 425.0
  hurt 425.0
  pain 425.0
Joints, not specified–Con.
  pulled muscle 425.0
  soreness 425.0
  spasm 425.0
  stiffness 425.0
  strain 425.0
  swelling 425.0

Knee (*see* Ankle and particular condition)
Knot (*see* Swelling and particular site)

Labor, possible 667.0
Laboratory test 920.0
Lack of (*see also* Absence)
  growth 009.0
  memory 058.0
  physiological development 009.0
Large menstrual flow 653.0
Leaking amniotic fluid 667.0
Left quadrant pain 540.0
Leg (*see* Ankle and particular condition)
Legal problems 941.0
Light, flashes 701.0
Lightheadedness 069.0
Lightness, sinus 304.0
Limbs, not specified (*see* Joints, not specified and particular condition)
Limited motion (*see* Ache and particular site)
Limping 421.0
Lips
  abnormal color 505.0
  bleeding 505.0
  cracked 505.0
  dry 505.0
  splitting 505.0
  symptoms of 505.0
Litigation, impending 941.0
Liver, symptoms of 580.0
Loneliness 806.0
Loose stools 555.0
Loss of
  appetite 545.0
  family member 941.0
  hair 124.0
  memory 058.0
  sense of equilibrium (balance) 069.0
  sense of smell 059.0
  sense of taste 059.0
  sense of touch 059.0
  weight 011.0
Lost feeling 807.0

- Low
  - blood pressure 206.0
  - sperm count 620.0
- Lower extremity, part unspecified (*see* Ankle and particular condition)
- Lower quadrant pain 540.0
- Lumbar (*see* Back and particular condition)
- Lumbosacral (*see* Back and particular condition)
- Lump (*see* Swelling and particular site)
- Lymph nodes, swollen 232.0

- Maladjustment, social 815.0
- Marital conflict 941.0
- Marital examination 904.0
- Mass (*see* Swelling and particular site)
- Medical examination 900.0
- Medication visit 910.0
- Member of family, recent loss 941.0
- Memory, disturbance of 058.0
- Menopause symptoms 650.0
- Menstrual
  - cramps 652.0
  - disorders 653.0
  - tension 651.0
- Migraine, headache 056.0
- Milk
  - absence of 684.0
  - excessive 684.0
- Misuse of medication or prescription drugs 822.0
- Mole 109.0
- Movements, abnormal (involuntary) 050.0
  - bladder 602.0
  - bowel 556.0
  - eye 708.0
- Murmur, heart 201.0
- Muscles (*see* particular site)
- Muscles, unspecified (*see* Joints, not specified and particular condition)

- Nails
  - biting 826.0
  - brittle 122.0
  - discoloration 122.0
  - falling out 122.0
  - splitting 122.0
  - spots 122.0
  - stained 122.0
- Nasal
  - bleeding 300.0
  - congestion 301.0
- Nausea 572.0
- Neck (*see* Face and particular condition)
- Nerves, Nervous, Nervousness 810.0
  - headache 056.0
- Night discharge 601.0
- Nightmares 062.0
- Nipple
  - discharge 683.0
  - inflammation 683.0
  - inversion 683.0
  - other symptoms 683.0
- Nodule (*see* Swelling and particular site)
- Noises, heard (nonpsychiatric) 731.0
- Noncodable entry 998.0
- Nonspecific pain 013.0
- Nose
  - bleed 300.0
  - drippy 301.0
  - hemorrhage 300.0
  - injury 410.0
  - red 301.0
  - runny 301.0
  - stuffy 301.0
- Not feeling well 005.0
- Numbness of extremities 420.0

- Obesity 010.0
- Obsession 827.0
- Oily
  - hair 124.0
  - skin 120.0
- Old age 065.0
- Overactivity
  - adult 805.0
  - infant 020.0
- Oversize
  - breast 690.0
  - ears 757.0
- Ovulation pain 654.0

- Pain (*see also* Ache and particular site)
  - abdominal 540.0
  - breast 681.0
  - chest 322.0
  - ear 735.0
  - epigastrium 540.0
  - eye 705.0
  - face 402.0
  - generalized 013.0
  - groin 540.0
  - head 056.0
  - iliac 540.0
  - inguinal 540.0
  - knee 400.0

- Pain–Con.
  - left quadrant 540.0
  - lips 505.0
  - lower quadrant 540.0
  - mouth 510.0
  - nonspecific 013.0
  - over heart 322.0
  - pelvic 660.0
  - penis 631.0
  - rectal 560.0
  - respiratory 322.0
  - retrosternal 322.0
  - rib 322.0
  - right quadrant 540.0
  - scrotum 621.0
  - side of chest 322.0
  - sinus 304.0
  - sternal 322.0
  - testicle 621.0
  - throat 520.0
  - upper quadrant 540.0
  - urinary 604.0
  - vaginal 661.0
  - vulva 663.0
- Painful
  - coitus 661.0
  - erection 621.0
  - tongue 525.0
  - umbilicus 126.0
  - urination 604.0
- Paleness 212.0
- Pallor 212.0
- Palpitation 200.0
- Panic 800.0
- Pap smear 904.0
- Paralysis of extremities, partial or complete 420.0
- Passed out 214.0
- Passed stones 620.0
- Peeling skin 120.0
- Pelvis pelvic
  - relaxed 660.0
  - sensation of dropping 660.0
  - symptoms of 660.0
- Penis
  - pain 631.0
  - swelling 631.0
- Phlegm
  - bloody 320.0
  - coughing up 320.0
- Phlegm–Con.
  - excessive 320.0
  - purulent 320.0
- Phobias 801.0
- Photo-
  - phobia 701.0
  - sensitivity 112.0
- Physiological development, lack of 009.0
- Physical therapy 911.0
- Pigmentation
  - nails 122.0
  - skin 104.0
- Pimples 100.0
- Pink-eye 712.0
- Plugged feeling in ear 937.0
- Poison ivy, oak, sumac 112.0
- Pooped 004.0
- Poor
  - blood 210.0
  - heart 216.0
- Popping in ear 737.0
- Possible labor 667.0
- Postnasal drip 301.0
- Postnatal examination 905.0
- Postoperative visit
  - specified condition 980.0
  - unspecified condition 985.0
- Postpartum breast problems 690.0
- Posture problems 422.0
- Pregnancy examination 905.0
- Prenatal examination 905.0
- Preoperative visit 950.0
- Pressure
  - chest 322.0
  - ear 737.0
  - pelvis 660.0
  - sinus 304.0
- Prickly feeling 059.0
- Problem (*see also* Trouble)
  - breathing 306.0
  - drinking (alcohol) 821.0
  - economic 941.0
  - family 941.0
  - female 670.0
  - legal 941.0
  - male 640.0
  - NOS 942.0
  - personal 942.0
  - posture 422.0
  - pregnancy 667.0

Problem–Con.
  - school 941.0
  - sexual 828.0
- Proceedings, divorce 941.0
- Products of conception passed 667.0
- Progress visit (*see also* Visit, followup)
  - specified condition 980.0
  - unspecified condition 985.0
- Psychiatric examination 902.0
- Psychosexual disorders 828.0
- Pulled muscle (*see* Ache and particular site)
  - unspecified site 425.0
- Pulsations, Pulse
  - decreased 200.0
  - increased 200.0
  - irregular 200.0
  - skipped beat 200.0
  - too fast 200.0
  - too slow 200.0
  - unequal 200.0
- Pupils unequal 708.0
- Purulent sputum 320.0
- Pus
  - eye 704.0
  - stools 556.0

- Quarrelsome 815.0

- Radiological examination 903.0
- Rales 307.0
- Rapid
  - breathing 307.0
  - heart 200.0
- Rash 112.0
  - diaper 112.0
- Receding hairline 124.0
- Rectal Rectum
  - bleeding 560.0
  - itching 560.0
  - mass 560.0
  - pain 560.0
  - swelling 560.0
  - symptoms of 560.0
- Red, Redness
  - eye 717.0
  - breast 681.0
  - nose 301.0
  - skin 104.0
  - umbilicus 126.0
- Referral from another physician or agency 970.0
- Regurgitation 574.0
- Relaxed pelvic floor 660.0
- Removal of
  - IUD 932.0
  - sutures 985.0
- Renewal of prescription 910.0
- Respiratory
  - insufficiency 306.0
  - pain 322.0
  - rhythm disorders 307.0
  - sighing 307.0
  - sound disorders 307.0
- Restlessness 805.0
- Retching 572.0
- Retention of
  - fluid 007.0
  - urine 603.0
- Retrosternal pain 322.0
- Rib pain 322.0
- Ridges, tongue 525.0
- Right quadrant pain 322.0
- Rigidity, abdominal 540.0
- Ringing in ear 731.0
- Rings on skin 104.0
- Ringworm 106.0
- Rough skin 120.0
- Routine inoculations 910.0
- Rundown 004.0
- Runny nose 301.0

- Sacroiliac (*see* Back and particular condition)
- Saliva, excessive 511.0
- Scales 120.0
- School problems 941.0
- Scratches
  - eye 716.0
  - skin 116.0
- Scratchy throat 520.0
- Scrotum, pain 631.0
- Seizure 054.0
- Senility 065.0
- Sensation
  - burning 059.0
  - burning (in chest) 322.0
  - falling 069.0
  - of suffocation 306.0
  - pelvis floor, dropping 660.0
  - smell (unusual) 059.0
  - taste (unusual) 059.0

- Sexual problem 828.0
- Shaking 050.0
- Shortness of breath 306.0
- Shots
  - allergy 910.0
  - injections 910.0
- Shoulder (*see* Arm and particular condition)
- Sick
  - feeling 005.0
  - head 056.0
  - stomach 572.0
- Side of chest, pain 322.0
- Sighing respiration 307.0
- Sinus
  - infection 304.0
  - pain 304.0
  - problem 304.0
- Skin
  - bulge 115.0
  - burning 059.0
  - change in color 104.0
  - clammy 120.0
  - cold 120.0
  - inflammation 113.0
  - irritation 113.0
  - mass 115.0
  - moles 109.0
  - rash 112.0
  - red 104.0
  - rings 104.0
  - rough 120.0
  - sores 113.0
  - thickened 120.0
  - warts 111.0
  - waxy 120.0
  - wrinkles 110.0
- Skipped beat 200.0
- Sleep
  - disturbances of 062.0
  - inability to 062.0
  - sleep walking 062.0
- Slow pulse 200.0
- Slowing of stream 610.0
- Smell
  - disturbance of 059.0
  - loss of sense of 059.0
  - unusual sensations of 059.0
- Smoking, excessive 820.0
- Smooth tongue 525.0
- Sneezing 310.0
- Sniffles 301.0
- Social maladjustments 815.0
- Sore
  - glands 232.0
  - skin 113.0
  - throat 520.0
- Soreness (*see* Ache and particular site)
- Sounds
  - breathing 307.0
  - respiratory, abnormal 307.0
  - unusual, in ear 731.0
- Spasm (*see* Ache and particular site)
  - eye 708.0
  - eyelid 710.0
- Spells 054.0
- Spine, thoracic spine (*see* Back and particular condition)
- Spine, cervical, upper spine (*see* Face and particular condition)
- Spitting up 574.0
- Splitting
  - lips 505.0
  - nails 124.0
- Spots
  - nails 124.0
  - skin 104.0
  - vision 701.0
- Sprain (*see* Ache and particular site)
- Sputum
  - coughing up 320.0
  - excessive 320.0
  - purulent 320.0
- Squinting 708.0
- Staggering 421.0
- Stammering 067.0
- Stand, inability to 421.0
- Sterility
  - female 665.0
  - male 630.0
- Sternal pain 322.0
- Stiffness (*see* Ache and particular site)
- Stomach
  - cramps 540.0
  - pain 540.0
  - upset 570.0
- Stones, passed 620.0
- Stools
  - abnormal 556.0
  - bloody 550.0
  - bulky 556.0
  - dark 556.0
  - fatty 556.0

- Stools–Con.
  - loose 555.0
  - pus in 556.0
  - unusual color 556.0
  - unusual odor 556.0
- Stopped up
  - ears 737.0
  - nose 301.0
  - sinuses 304.0
- Strain (*see* Ache and particular site)
- Stream, slowing of 610.0
- Stuffy nose 301.0
- Stupor 052.0
- Stuttering 067.0
- Sty 711.0
- Suffocation, sensation 306.0
- Surgery, (minor) visit 950.0
- Surgical aftercare
  - specified condition 680.0
  - unspecified condition 685.0
- Swallowing difficulties 528.0
- Sweating Sweats
  - excessive 007.0
  - night 007.0
- Swelling
  - abdominal 542.0
  - ankle 400.0
  - arm 405.0
  - back 415.0
  - back of head 410.0
  - breast, generalized 681.0
  - breast, local 680.0
  - cervical spine 410.0
  - ear 740.0
  - elbow 405.0
  - eye 705.0
  - eyelid 710.0
  - face 410.0
  - fingers 405.0
  - foot 400.0
  - forearm 405.0
  - generalized 015.0
  - hand 405.0
  - hip 400.0
  - jaw 410.0
  - joints, not specified 425.0
  - joints specified (*see* site)
  - knee 400.0
  - leg 400.0
  - limbs, not specified 425.0
  - lower back 415.0
- Swelling–Con.
  - lower extremity, part unspecified 400.0
  - lumbar 415.0
  - lumbosacral 415.0
  - neck 410.0
  - pelvis 660.0
  - penis 631.0
  - sacroiliac 415.0
  - scrotum 631.0
  - shoulder 405.0
  - site unspecified 015.0
  - skin 115.0
  - testicle 631.0
  - tongue 525.0
  - tonsils 527.0
  - upper extremity, part unspecified 405.0
  - vagina 661.0
  - vulva 663.0
- Swollen
  - ankles 400.0
  - glands 232.0
- Syncope 214.0

- Taste
  - disturbance of 059.0
  - loss of sense of 059.0
  - unusual sensation 059.0
- Tearing of eye 704.0
- Teeth, symptoms of 515.0
- Temperature, high 002.0
- Temper tantrums 815.0
- Temporary loss of memory 058.0
- Tender
  - breast 681.0
  - skin 113.0
- Tension
  - headache 056.0
  - nervous 810.0
  - premenstrual 651.0
- Test, laboratory 920.0
- Testicle
  - pain 631.0
  - swelling 631.0
- Texture, change in skin 120.0
- Thickened skin 120.0
- Thigh (*see* Ankle and particular condition)
- Thin blood 210.0
- Thirst, excessive 007.0
- Throat
  - culture 920.0
  - pain 520.0

Throat–Con.
    scratchy 520.0
    soreness 520.0
Throwing up 572.0
Thumb (*see* Arm and particular condition)
    sucking 826.0
Tic 050.0
Tightness of chest 322.0
Time-zone syndrome 062.0
Tingling 059.0
Tired 004.0
    blood 210.0
Toe (*see* Ankle and particular condition)
    blueness 212.0
Tongue
    bleeding 525.0
    coated 525.0
    mass 525.0
    painful 525.0
    smooth 525.0
    swelling 525.0
    symptoms of 525.0
Tonsils, symptoms of 527.0
Toothache 512.0
Touch, loss of sense of 059.0
Tremor 050.0
Trouble (*see also* Problem)
    breathing 306.0
    eating 546.0
    female 670.0
    hearing 731.0
    job 941.0
    marital 941.0
    school 941.0
    seeing 701.0
    sleeping 062.0
    walking 421.0
Twitching 050.0
    eyes 708.0

Ulcer
    mouth 510.0
    skin 113.0
    tongue 525.0
    vulva 663.0
Umbilical region, pain 540.0
Umbilicus
    discharge 126.0
    draining 126.0
    painful 126.0
    red 126.0
Umbilicus–Con.
    symptoms of 126.0
    unhealed 126.0
Under
    activity (infants) 020.0
    weight 011.0
Unequal
    pulse 200.0
    pupils 708.0
Unusual
    color of stools 556.0
Upper arm (*see* Arm and particular condition)
Upper extremity, part unspecified (*see* Arm and particular condition)
Upper quadrant, pain 540.0
Upset
    emotional 810.0
    stomach 570.0
Urinary
    dysfunction 610.0
    pain 604.0
    symptoms NEC 610.0
Urination urinate
    frequent 601.0
    hesitancy 610.0
    inability to 603.0
    painful 604.0
Urine
    blood 600.0
    incontinence of 602.0
    pus 600.0
    retention of 603.0
    unusual color 600.0
    unusual odor 600.0
Use of orthopedic aids (instruction) 940.0

Vaccinations 910.0
Vaginal vagina
    atypical discharge 662.0
    bleeding 662.0
    brown discharge 662.0
    discharge 662.0
    disorders 661.0
    mass 661.0
    pain 661.0
    swelling 661.0
Vasectomy
    advice regarding 930.0
    request 932.0
Vertigo 069.0

Vision
  blurred 701.0
  diminished 701.0
  disturbance of 701.0
Visit, advice and instruction (*see* 940.0-942.0)
Visit, examination
  eye 909.0
  general medical 900.0
  general psychiatric 902.0
  gynecological 904.0
  other 909.0
  physical 901.0
  pregnancy 905.0
  radiological 903.0
  well baby 906.0
Visit, family planning services
  counseling 930.0
  medication 931.0
  other 935.0
  services 932.0
Visit followup (*see* Progress visit)
Visit, minor surgery 950.0
Visit, preoperative 950.0
Visit, progress
  specified condition 980.0
  unspecified condition 985.0
Visit, referral 970.0
Visit, testing
  laboratory 920.0
  other 921.0
Visit, therapy
  medication 910.0
  other therapy 911.0
Vitamins or hormones, injections 910.0
Voice, change in 325.0
Vomiting 572.0
  blood 550.0
Vulvar disorders
  itching 663.0
  mass 663.0

Vulvar disorders—Con.
  pain 663.0
  swelling 663.0
  ulcer 663.0

Walk, Walking
  difficulty in 421.0
  inability to 421.0
Warts 111.0
Wasting of extremities 420.0
Watering of eye 704.0
Waxy skin 120.0
Weak
  blood 210.0
  heart 216.0
Weakness
  generalized 004.0
  of extremities 420.0
Weight
  gain 010.0
  loss 011.0
  under 011.0
Well-baby examination 906.0
Welts 115.0
Wheezing 307.0
Whiteheads 100.0
Worn out 004.0
Worrying 807.0
Wounds (skin)
  bites 116.0
  blisters, nonallergic 116.0
  bruises 116.0
  burns 116.0
  cuts 116.0
  scratches 116.0
Wrinkles 110.0
Wrist (*see also* Arm and particular condition)
  drop 422.0

X-rays 903.0

Schedule C

Vital Signs Codes

Temperature (°F):		0	Unknown, no entry	3	99-100
		1	103 or above	4	98
		2	101-102	5	97 or below
Pulse: :		0	Unknown, no entry	3	86-99
		1	120 or more	4	65-85
		2	100-119	5	64 or less
Respiration :		0	Unknown, no entry	3	10-19
		1	30 or above	4	9 or less
		2	20-29		
Blood Pressure :	(S)	0	Unknown, no entry	(D) 0	Unknown, no entry
		1	200 or more	1	100 or more
		2	150-199	2	85-99
		3	110-149	3	75-84
		4	90-109	4	60-74
		5	89 or less	5	59 or less

SCHEDULE D

DIAGNOSTIC DATA CODES

Test	Codes						
	1 (Normal)	2	3	4	5	6	7
Hgb.	Male: 14-18 gm/100 ml. Female: 12-16 gm/100 ml.	↑	↓				
WBC	5-10,000	↑	↓				
Lymphs	20-40%	↑	↓				
EOS	1-3%	↑					
SGOT	5-40 units	↑					
T. Protein	Serum: 6-8 gm/100 ml. Urine: "Negative"	↑					
Albumin	Serum: 3.5-5.5 gm/100 ml. Urine: "Negative"	↑					
Globulin	Serum: 1.5-3 gm/100 ml. Urine: "Negative"	↑					
Blood Gas Summary							
pH*	7.35-7.45	↓	↑	↓	↑	→	→
PCO_2*	35-45 mmHg.	↑	↓	↓	↑	↑	↓
CO_2	24-29 mEq/l.	↑	↓	↓	↑	↑	↓
* Code by these values if CO_2 is normal or not given.							
Na	136-145 mEq/l.	↑	↓				
K	2.5-5 mEq/l.	↑	↓				
Cl	100-106 mEq/l.	↑	↓				
HCO_3	26-30 mEq/l.	↑	↓				

Legend:

- ↑ above normal
- ↓ below normal
- → normal range

PATIENT INTERVIEW INSTRUCTIONS

1.0 INTRODUCTION

Attached is an interview which will be conducted by telephone with patients who have visited the emergency room over the past months. The interview provides information beyond that usually found in the medical record and it is intended to better define sensitivity to air pollution effects, extent of exposure to pollutants, and patterns of illness. Through the combined sources of data a more precise approach to measurement of excess illness associated with various pollution levels may be constructed for use in large-scale community studies.

Although some items have been used in past studies, at this point the data collection forms and procedures are untested. The purpose of data collection in the next few weeks is to provide an evaluation of the interview as to the amount, quality and utility of information it produces. For this reason it is very important that:

1) The interviewer closely adhere to the procedures and interview questions

2) The interviewer pays close attention to factors related to reaching the respondent and conducting the interview.

Only by careful observation of a standardized process can we determine what works well, what is deficient, and what type of modifications might be appropriate.

2.0 GENERAL INSTRUCTIONS

Follow the sequence of steps listed below. Since this is a pilot test specific changes may be made by the Project Director from time to time, based on interviewer observations, in an attempt to improve the interviewing.

1) Select sample of patients for interviewing (see separate instructions on sampling).

2) Complete top and bottom section (identifying information) of interview cover page from medical record -- at time record abstract is prepared.

3) If necessary, try other sources such as Directory Assistance and city street indexes to locate useful telephone numbers for reaching respondent.

4) Fill in blanks in interview questions (month of visit, first name of respondent, town of residence, etc.) to prepare for interview.

5) Attempt telephone call. Up to eight calls should be made to reach the patient's residence or to some other appropriate telephone number for a suitable respondent. Record date and time of attempt.

6) If the patient's residence or some other appropriate number is reached, but a suitable respondent is not available at that time, two callbacks to that number should be made to reach a suitable respondent before abandoning the interview attempt. Make note on best time to reach a suitable respondent and other pertinent information.

7) When interview is completed or attempts terminated, complete remainder of interview record on cover page.

8) Edit interview to determine that entries are complete and interviewer comments are clear.

9) Remove bottom section of interview cover sheet and file this section in order of study number.

10) File interview in order of study number in a separate file.

11) Forward completed interviews to GEOMET at the end of each week.

These steps are described in more detail below.

2.1 Interview Preparation

At the time the record is abstracted the medical record abstractor will complete the following items on the interview cover sheet for those cases selected to be interviewed:

- Top section - study number, log number, hospital number, date of ER visit
- Bottom section - patient name, address, residence telephone, age, sex, parent's name (if patient is under 18 years and living at home).

Location of the patient and further preparation for the interview is the responsibility of the interviewer. Even if a residence telephone is not listed on the current clinic form there may be additional information in the chart which would be useful in locating the patient. However, we neither wish to slow down the abstracting process nor keep the records out of file too long. To review the record for the additional clues, we suggest trying combinations of the following:

- Pulling the records a second time for interviewer review
- Review by the interviewer of those records without telephone numbers at the time they are identified by the abstractor
- Designation of specific but limited additional items by the interviewer that would be entered by the abstractor.

To illustrate, if there is no residence telephone the abstractor might enter any other telephone numbers or names that appear on the current clinic form (parents, employer, responsible party). The interviewer would then utilize this data in location. If this information is not available, the record would be re-pulled for further interviewer review. Every few days the interviewer would review these special records and any others that were currently pulled for abstracting. Some practical arrangement should be worked out which will not put an excess burden on the abstractor and minimize the need to pull records a second time.

The second step in interview preparation involves filling in the reference blanks in the body of the interview: first or last name of patient, town of residence, month of ER visit. While this information will be on the cover sheet, it is often more efficient to insert the reference in the appropriate question prior to starting the interview.

NOTE: To maintain confidentiality of the data full names, street address, telephone numbers, employer and relative names, and other identification should only be written in the bottom section of the cover sheet. This section will then be removed before the completed interview is sent to GEOMET.

2.2 Interview Respondent and Attempts

Preference of respondent for the interview is in the following order:

- First - patient (if 18 years or older)
  mother (if under 18 years)
- Second - mother or spouse
- Third - any adult who claims to be knowledgeable of the patient's health and medical care.

Up to eight (8) calls to locate the patient or a suitable respondent should be made. Once someone is reached at the patient's residence or other location where a suitable respondent may be contacted, but the respondent is not available at the time, two (2) callbacks to this telephone should be made in an attempt to talk to the person you want. Information should be obtained as to the best time to try to reach the respondent. After 8 location calls and/or 2 callbacks, attempts to obtain the interview should be terminated.

NOTE: The interviewer should not give out her full name, address or home telephone number on any calls. Always insist on calling the party back.

2.3 Interview Conduct and Editing

Since this is a pilot test it is important both to get the information and to understand why the information was not obtained. It is also important to observe whether the question produced a valid response, or whether the respondent was confused or misunderstood the question. Consequently, the interviewer should attempt to note down any observations that may help interpret a response or lack of response. Also, some probing should be used when there is an indication that the nature of the question is not clear to the respondent.

A brief guide on General Interviewing Procedures has been included with the instruction package. This may be useful in conducting and editing the interviews. In particular, note the editing entries to account for each question: INAP when the question is skipped, REF when the respondent refuses to answer, and ✓ Don't know when the respondent doesn't know or can't remember.

3.0 INSTRUCTIONS FOR SPECIFIC ITEMS

3.1 Interview Recording Form

Interviewer - Enter interviewer initials.

Study number, etc. - This row is completed by abstractor.

Call Record - Enter date and time for each attempt to reach a suitable respondent or any information/location calls. In the "Notes" section record any information and time you need for the next callbacks, and why you did not reach respondent on that call.

Final Status - When interviewing is terminated check box indicating status. If "Other", explain why the interview was not completed.

Respondent - Check which type of respondent was interviewed.

Time for Interview - The Time of Try should be entered when you pick up the phone to call. When an interview is finished, note the time at the bottom of the last page. The difference (in minutes) is entered on the cover page as the time for the interview. No entry need be made for refused interviews or unsuccessful attempts.

3.2 Introduction Page

Use the statements given to introduce the interview. DO NOT mention that this study concerns ozone or air pollution, just indicate that we are trying to learn more about persons who use emergency rooms (which is true!). Consult the interview guide for help on this.

3.3 Interview Questions

The exact wording of the question you are to ask is on the left; boxes for check-off of the response are on the right. Numbers in circles indicate that when that response is given, you are to skip to the question shown. If there is no circled number for the response, you are to continue with the next question in sequence. In some cases the response should be written on the lines provided by the question, with the proper code for the response entered later.

Most of the questions are obvious; special situations are described below.

Ques. 1 - "Working or combination" means working, working and keeping house, working and attending school, or any situation where the patient is employed part-time or full-time.

Ques. 5 - If the patient does not work in the town where he lives, enter the proper place. Later, check Metro Area if patient works in a town on our patient selection list; otherwise, check Outside Metro Area.

Ques. 7 - "Inside" means inside a building.

Ques. 9 - Same situation as Ques. 5.

Ques. 13 - The categories may be confusing; you may have to repeat them.

Ques. 14 - Read each condition and have the respondent answer; then go on to the next condition.

Ques. 15 - Write down the health problem in the respondent's own words. We will assign a code later.

Ques. 16 - Same situation as Ques. 15.

Ques. 17 - Read slowly and repeat if necessary. It may help to ask which symptom was the most severe and when it started. If so, note which symptom you used.

Ques. 18 - This may require some explanation. We are referring to the usual, normal major daily activities of the patient and whether he had to cut back on the things he typically does: work, school, play, housework, working around the house, or whatever.

Ques. 19 - Allow time to remember. Use the day before the visit as a reference point.

Ques. 21 - Emphasize that we are interested in the 12 months prior to the visit, not 12 months before the interview.

Ques. 22 - This may be confusing. We are interested where the patient was during the daytime on that day the symptom(s) started. Refer to the list to determine if that place is in the metro area.

Ques. 25 - Refer to metro list if respondent asks whether any particular town is considered "around Riverside." Include only time spent in metro area. We will code response later.

Ques. 27 - This refers to gross estimated total annual income of all family members living at that residence. If the patient is an elderly relative, just obtain the patient's income.

Ques. 28 - Write down respondent's answer, although you don't need to enter a verbatim response -- just summary phrases. We will code later.

NOTE:

If age, sex was not in the medical record get this on the interview. If the patient doesn't live in the town given in the record, note the proper town on the interview.

Enter any comments on the answer side of the page. Make sure they are clear and separate from the answer boxes. Check the response you feel fits the best.

Ozone Effects Study

GEOMET, Inc.
October 1975

Interview Coding

Item		Format	CC
Study #		XXXX	1-4
E.R. Log #		XXX	5-7
Date E.R. Visit (mo., day)		XXXX	8-11
# Calls (1-8)		X	12
Final Status:	1 - Complete 2 - Partial 3 - Referred 4 - No phone 5 - Moved from area 6 - Out-of-area resident 7 - Can't locate 8 - Other	X	13
Respondent:	1 - Patient 2 - Mother/spouse 3 - Other	X	14
Interview time: (# minutes)		XX	15-16
Q1		X	17
Q2	5 - Invalid 6 - Preschooler 7 - Other - home 8 - Undetermined	X	18
Q3		X	19
Q4		X	20
Q5	If code 1 then add city code. If code 0, 2 then add 00.	XXX	21-23
Q6		X	24
Q7		X	25
Q8		X	26
Q9	If code 1 then add city code. If code 0, 2 then add 00.	XXX	27-29

(cont.)

Item			Format	CC
Q10			X	30
Q11			X	31
Q12			X	32
Q13			X	33
Q14	Punch a - i separately. 0 - Don't know 1 - Yes 2 - No		(9)	34-42
Q15	H-ICDA Code		XXXX	43-46
Q16	Symptom codes	#1	XXXX	47-50
		#2	XXXX	51-54
		#3	XXXX	55-58
Q17			X	59
Q18			X	60
Q19			X	61
Q20			X	62
Q21			X	63
Q22			X	64
Q23			X	65
Q24			X	66
Q25	# years		XX	67-68
Q26			X	69
Q27			X	70
Q28	Code for reason (to be developed)		XX	71-72
Card "3"			X	80

Interview: Question #28

01	Referred by RGH social service staff
02	Clinic card
03	Closest source after hours
04	Only source patient can get care
05	Low income
06	Brought by authorities
07	Brought by ambulance
08	Second source after seeking care elsewhere
09	Regular source of care
10	Emergency facilities of RGH
11	No regular doctor

Definitions of Diagnosis Groups Used in Analysis

Diagnostic Group	H-ICDA Codes
1. Asthma	4930-4939
2. Chronic Respiratory Disease: Chronic Bronchitis, Emphysems, Chronic Obstructive Lung Disease	4910-4929, 4960
3. Acute Lower Respiratory Disease: Pneumonia, Bronchitis, Pleurisy, Acute Pulmonary Edema	4800-4869, 4890-4909, 5110, 5119, 5191
4. Lower Respiratory Symptoms: Pulmonary Congestion, Chest Pain, Respiratory Difficulty, Lower Respiratory Symptoms	5140, 5149, 5197, 7740, 7780-7789, 7790-7791, 7793, 7794, 7963, 7968
5. Acute Upper Respiratory Disease: Septic Sore Throat, Acute Upper Respiratory Infections, Peritonsillitis	0340, 4600-4659, 501
6. Upper Respiratory Symptoms: Chronic Pharyngitis, Allergy, Earache, Nasal Congestion, Sore Throat	5020-5039, 5070, 7720-7722, 7760-7769, 7776-7777
7. Otitis Media, Otitis Externa	380, 381
8. Eye Irritation: Conjunctivitis, Belphoritis, Inflammation and Soreness	0789, 3600-3619, 7711
9. Flu: Influenza, Viral Syndrome	0799, 4700
10. Chills, Fever	7922, 7929
11. Vertigo, Dizziness, Headache: (Migraine, Tension, Other)	7704-7705, 7920, 3168, 346
12. Cardiovascular Disorders and Symptoms	4100-4299, 7741-7746, 7750, 7755
13. Cerebrovascular Disorders	4300-4389
14. Hypertension and Elevated Blood Pressure	4000-4059, 7747
15. Nonphysical Psychoses and Personality Disorders	3060-3099, 3110-3119, 3169
16. Anxiety, Depression, Nerves, Neuroses	3100, 3105, 3109, 317, 7926
17. Epilepsy, Convulsions, Seizures	3450-3459, 7703
18. Diabetes Mellitus	2500-2509
19. Upper G.I. Ulcers, G.I. Bleeding	5310-5349, 7820
20. Gastroenteritis, Gastritis, Diarrheal Disease	0080-0099, 5350-5351, 7821
21. Abdominal Symptoms: Pain, Nausea, Vomiting, Flatulence	5369, 7800-7801, 7816, 7823, 7824

Definition of Symptom (Complaint) Groups Used in Analysis

	Symptom Group	NCHS Code	Table Name
1.	Chills, Fever	001, 002	FEVR
2.	Fatigue, Ill Feeling	004, 005	ILL
3.	Coma, Stupor	052	COMA
4.	Convulsions	054	CONV
5.	Headache	056	HACHE
6.	Vertigo, Dizziness	069	DIZY
7.	Cardiovascular System	200, 201, 216, 220	HEART
8.	High Blood Pressure	205	BP
9.	Respiratory System	300-399	RESP
10.	Musculoskeletal	400-499	MUSC
11.	Digestive System	500-599	DIG
12.	Eyes	700-720	EYES
13.	Ears	730-740	EARS
14.	Mental Health	800-899	MENT
15.	Referral Visit	970	REFR
16.	Followup, Progress Visit	980, 985	PROG
17.	Not Elsewhere Classified	990.0	NEC
18.	Diabetic	990.1	DIAB

Appendix B

COMPUTER MODEL AND OUTPUT FOR OZONE CONCENTRATION MAPPING

```
//TOTAL JOB (8170,5212-1),LEBOWITZ,CLASS=H,TIME=1                                   JOB  784
// EXEC FORTGCLG,PARM.FORT=ID,PARM.LKED=NOXREF
XXFORTGCLG  PROC CODE=5,DISP='(SHR,PASS)',SYSLMOD='&&SYSLMOD(GO)',                00000010
XX              LMODISP='(NEW,PASS)',LINDISP='(MOD,PASS)',LINES=60                00000020
***  COMPILE PROCEDURE FORTRAN GI LEVEL COMPILER **08/04/78**                     00000030
XXFORT       EXEC PGM=IGIFORT,PARM='LINECNT=&LINES'                               00000040
IEF653I SUBSTITUTION JCL - PGM=IGIFORT,PARM='LINECNT=60'
XXSYSLIN    DD DSN=&&SYSLIN,DISP=&LINDISP,UNIT=SYSDA,                             00000050
IEF653I SUBSTITUTION JCL - DSN=&&SYSLIN,DISP=(MOD,PASS),UNIT=SYSDA,
XX              SPACE=(CYL,(2,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=3120)            00000060
XXSYSPRINT DD SYSOUT=A                                                            00000070
//FORT.SYSIN DD *
IEF236I ALLOC. FOR TOTAL    FORT
IEF237I 261   ALLOCATED TO SYSLIN
IEF237I 68E   ALLOCATED TO SYSPRINT
IEF237I 804   ALLOCATED TO SYSIN
IEF142I - STEP WAS EXECUTED - COND CODE 0000
IEF285I   SYS75282.T206405.RV000.TOTAL.SYSLIN            PASSED         SIO=0000004
IEF285I   VOL SER NOS= 21VS99.
IEF373I STEP /FORT    / START 75283.1016
IEF374I STEP /FORT    / STOP  75283.1017 CPU   0MIN 01.02SEC STOR VIRT 118K
***LRCC STEP /FORT    / START I-O COUNT DASD=0000004. TAPE=0000000
***LRCC STEP /FORT    / PAGING STATS      IN=0000000.  OUT=0000000
XXLKED      EXEC PGM=IEWL,PARM='LIST,XREF,LET',                                   00000080
XX          COND=(&CODE,LT,FORT),REGION=128K                                      00000090
IEF653I SUBSTITUTION JCL - COND=(5,LT,FORT),REGION=128K
XXSYSLIB    DD DSN=SYS1.FORTLIB,DISP=SHR                                          00000100
XXSYSLIN    DD DSN=&&SYSLIN,DISP=&DISP                                            00000110
IEF653I SUBSTITUTION JCL - DSN=&&SYSLIN,DISP=(SHR,PASS)
XX          DD DDNAME=SYSIN                                                       00000120
XXSYSLMOD   DD DSN=&SYSLMOD,DISP=&LMODISP,UNIT=SYSDA,                             00000130
IEF653I SUBSTITUTION JCL - DSN=&&SYSLMOD(GO),DISP=(NEW,PASS),UNIT=SYSDA,
XX              SPACE=(CYL,(1,,1))                                                00000140
XXSYSPRINT DD SYSOUT=A                                                            00000150
XXSYSUT1    DD UNIT=SYSDA,SPACE=(CYL,(3,1))                                       00000160
IEF236I ALLOC. FOR TOTAL    LKED
IEF237I 190   ALLOCATED TO SYSLIB
IEF237I 261   ALLOCATED TO SYSLIN
IEF237I 261   ALLOCATED TO SYSLMOD
IEF237I 68E   ALLOCATED TO SYSPRINT
IEF237I 261   ALLOCATED TO SYSUT1
IEF142I - STEP WAS EXECUTED - COND CODE 0000
IEF285I   SYS1.FORTLIB                                   KEPT           SIO=0000098
IEF285I   VOL SER NOS= 21VS23.
IEF285I   SYS75282.T206405.RV000.TOTAL.SYSLIN            PASSED         SIO=0000005
IEF285I   VOL SER NOS= 21VS99.
IEF285I   SYS75282.T206405.RV000.TOTAL.SYSLMOD           PASSED         SIO=0000021
IEF285I   VOL SER NOS= 21VS99.
IEF285I   SYS75282.T206405.RV000.TOTAL.R0013980          DELETED        SIO=0000060
IEF285I   VOL SER NOS= 21VS99.
IEF373I STEP /LKED    / START 75283.1017
IEF374I STEP /LKED    / STOP  75283.1017 CPU   0MIN 00.28SEC STOR VIRT 128K
***LRCC STEP /LKED    / START I-O COUNT DASD=0000184. TAPE=0000000
***LRCC STEP /LKED    / PAGING STATS      IN=0000000.  OUT=0000000
XXGO        EXEC PGM=*.LKED.SYSLMOD,                                              00000170
XX              COND=((&CODE,LT,FORT),(&CODE,LT,LKED))                            00000180
IEF653I SUBSTITUTION JCL - COND=((5,LT,FORT),(5,LT,LKED))
XXDELETE2  DD DSN=&&SYSLIN,DISP=(OLD,DELETE)                                      00000190
XXFT05F001 DD DDNAME=SYSIN                                                        00000200
XXFT06F001 DD SYSOUT=A                                                            00000210
XXFT07F001 DD SYSOUT=B                                                            00000220
//GO.FT11F001 DD *
//GO.FT12F001 DD *
```

```
//GO.FT14F001 DD *
//
IEF236I ALLOC. FOR TOTAL    GO
IEF237I 261    ALLOCATED TO PGM=*.DD
IEF237I 261    ALLOCATED TO DELETE2
IEF237I 68F    ALLOCATED TO FT06F001
IEF237I 650    ALLOCATED TO FT07F001
IEF237I 604    ALLOCATED TO FT11F001
IEF237I 607    ALLOCATED TO FT12F001
IEF237I 608    ALLOCATED TO FT13F001
IEF237I 609    ALLOCATED TO FT14F001
IEF142I - STEP WAS EXECUTED - COND CODE 0000
IEF285I   SYS75282.T206405.RV000.TOTAL.SYSLMOD         PASSED       SIO=0000001
IEF285I   VOL SER NOS= 21VS99.
IEF285I   SYS75282.T206405.RV000.TOTAL.SYSLIN          DELETED      SIO=0000000
IEF285I   VOL SER NOS= 21VS99.
IEF373I STEP /GO       / START 75283.1017
IEF374I STEP /GO       / STOP  75283.1017 CPU   0MIN 01.86SEC STOR VIRT  48K
***LRCC STEP /GO       / START I-O COUNT DASD=0000001, TAPE=0000000
***LRCC STEP /GO       / PAGING STATS      IN=0000000,  OUT=0000000
IEF285I   SYS75282.T206405.RV000.TOTAL.SYSLMOD         DELETED
IEF285I   VOL SER NOS= 21VS99.
IEF375I  JOB /TOTAL    / START 75283.1016
IEF376I  JOB /TOTAL    / STOP  75283.1017 CPU   0MIN 03.16SEC
```

```
0001               INTEGER M(4,24,31),MLEN(12),MNAME(12),SUM,SUM2,AVEDAY,AVEHR,
                  *DIST(31),DIST1(31),DIST3(31),DEL,DAYM(12),DAYS(12),ROMAN(3)
0002               DATA MLEN/31,28,31,30,31,30,31,31,30,31,30,31/
0003               DATA MNAME/'JAN ','FEB','MAR','APR','MAY','JUNE','JULY','AUG',
                  *'SEPT','OCT','DEC'/
0004               DATA ROMAN/'I','II','III'/
0005          1000 NDAY=0
0006             1 NDAY=NDAY+1
0007               READ(11,100,END=3000)ID1,(M(1,I,NDAY),I=1,24)
0008               READ(12,100,END=2000)ID2,(M(2,I,NDAY),I=1,24)
0009               READ(13,100,END=2000)ID3,(M(3,I,NDAY),I=1,24)
0010               READ(14,100,END=2000)ID4,(M(4,I,NDAY),I=1,24)
0011           100 FORMAT(I6,14X,24I2)
0012               IF(ID1.NE.ID2 .OR. ID2.NE.ID3 .OR. ID3.NE.ID4)GOTO 2000
0013               MY=ID1/100
0014               IYR=MY/100
0015               MO=MY-IYR*100
0016               IF(MLEN(MO).GT.NDAY)GOTO 1
              C
              C    COMPUTE NIGHT BACKGROUND
              C
0017               NOBS=0
0018               SUM=0
0019               SUM2=0
0020               DO 10 ND=1,NDAY
0021               DO 10 I=1,12
0022               II=I
0023               IF(II.GT.9)II=II+12
0024               DO 10 J=1,2
0025               IF(M(J,II,ND).EQ.99)GOTO 10
0026               NOBS=NOBS+1
0027               SUM=SUM+M(J,II,ND)
0028               SUM2=SUM2+M(J,II,ND)**2
0029            10 CONTINUE
0030               AVENGT=FLOAT(SUM)/FLOAT(NOBS)
0031               SDNGT=SQRT(FLOAT(SUM2)/FLOAT(NOBS)-AVENGT*AVENGT)
0032               NGTBGR=IFIX(AVENGT+SDNGT/2.+.5)
              C
              C    ACCUMULATE NIGHT DISTRIBUTION
              C
0033               NEV=0
0034               DO 11 I=1,31
0035               DIST1(I)=0
0036               DIST3(I)=0
0037            11 DIST(I)=0
0038               DO 12 ND=1,NDAY
0039               DO 12 I=1,12
0040               II=I
0041               IF(II.GT.9)II=II+12
0042               DO 12 J=1,2
0043               IF(M(J,II,ND).EQ.99)GOTO 12
0044               NEV=NEV+1
```

```
                 C      TYPE 2 DAY
                 C
 0084                   ITYP=2
 0085                   DO 28 I=1.12
 0086                   NOBS=0
 0087                   SUM=0
 0088                   DO 27 J=1.2
 0089                   IF(M(J.I+9.ND).EQ.99)GOTO 27
 0090                   NOBS=NOBS+1
 0091                   SUM=SUM+M(J.I+9.ND)
 0092                27 CONTINUE
 0093                   AVEHR=-1
 0094                   IF(NOBS.NE.0)AVEHR=SUM/NOBS
 0095                   DAYN(I)=AVEHR
 0096                   DAYS(I)=AVEHR
 0097                28 CONTINUE
 0098                   GOTO 80
                 C
                 C      TYPE 3 DAY
                 C
 0099                30 ITYP=3
 0100                   DO 31 I=1.12
 0101                   DAYS(I)=M(1.I+9.ND)
 0102                   IF(DAYS(I).EQ.99)DAYS(I)=-1
 0103                   NOBS=0
 0104                   SUM=0
 0105                   DO 32 J=2.4
 0106                   IF(M(J.I+9.ND).EQ.99)GOTO 32
 0107                   NOBS=NOBS+1
 0108                   SUM=SUM+M(J.I+9.ND)
 0109                32 CONTINUE
 0110                   AVEHR=-1
 0111                   IF(NOBS.NE.0)AVEHR=IFIX(FLOAT(SUM)/FLOAT(NOBS)+.5)
 0112                   DAYN(I)=AVEHR
 0113                   DO 33 J=2.4
 0114                   IF(M(J.I+9.ND).EQ.99)GOTO 33
 0115                   NEV3=NEV3+1
 0116                   DEL=M(J.I+9.ND)-AVEHR+16
 0117                   IF(DEL.GT.31)DEL=31
 0118                   IF(DEL.LT.1)DEL=1
 0119                   DIST3(DEL)=DIST3(DEL)+1
 0120                33 CONTINUE
 0121                31 CONTINUE
                 C
                 C      OUTPUT A DAY
                 C
 0122                80 WRITE(6.203)ND.ROMAN(ITYP).NGTBGR.(DAYN(I).DAYS(I).I=1.12).NGTBGR
 0123               203 FORMAT(1X.I4.3X.A4.I3.12(I5.I3).I5)
 0124                15 CONTINUE
                 C
                 C      OUTPUT DISTRIBUTION SUMMARIES
                 C
```

```
C       TYPE 2 DAY
C
           ITYP=2
           DO 28 I=1.12
           NOBS=0
           SUM=0
           DO 27 J=1.2
           IF(M(J.I+9.ND).EQ.99)GOTO 27
           NOBS=NOBS+1
           SUM=SUM+M(J.I+9.ND)
        27 CONTINUE
           AVEHR=-1
           IF(NOBS.NE.0)AVEHR=SUM/NOBS
           DAYN(I)=AVEHR
           DAYS(I)=AVEHR
        28 CONTINUE
           GOTO 80
C
C       TYPE 3 DAY
C
        30 ITYP=3
           DO 31 I=1.12
           DAYS(I)=M(1.I+9.ND)
           IF(DAYS(I).EQ.99)DAYS(I)=-1
           NOBS=0
           SUM=0
           DO 32 J=2.4
           IF(M(J.I+9.ND).EQ.99)GOTO 32
           NOBS=NOBS+1
           SUM=SUM+M(J.I+9.ND)
        32 CONTINUE
           AVEHR=-1
           IF(NOBS.NE.0)AVEHR=IFIX(FLOAT(SUM)/FLOAT(NOBS)+.5)
           DAYN(I)=AVEHR
           DO 33 J=2.4
           IF(M(J.I+9.ND).EQ.99)GOTO 33
           NEV3=NEV3+1
           DEL=M(J.I+9.ND)-AVEHR+16
           IF(DEL.GT.31)DEL=31
           IF(DEL.LT.1)DEL=1
           DIST3(DEL)=DIST3(DEL)+1
        33 CONTINUE
        31 CONTINUE
C
C       OUTPUT A DAY
C
        80 WRITE(6.203)ND.ROMAN(ITYP).NGTRGR.(DAYN(I).DAYS(I).I=1.12).NGTRGR
       203 FORMAT(1X.I4.3X.A4.I3.12(I5.I3).I5)
        15 CONTINUE
C
C       OUTPUT DISTRIBUTION SUMMARIES
C
```

```
 0125              WRITE(6.300)MNAME([illegible]).NGTBGA
 0126          300 FORMAT('1'. 4X.A4.' NIGHT DISTRIBUTION. BACKGROUND VALUE ='.I3/
                  * 4X.' DIFFERENCE BETWEEN RIVERSIDE OR CORONA AND BACKGROUND')
 0127              CALL PRTDIS(DIST.NEV)
 0128              WRITE(6.301)MNAME([illegible])
 0129          301 FORMAT('1'. 4X.A4.' DISTRIBUTION OF TYPE I DAYS'/6X.
                  *' RIVERSIDE OR CORONA - DAILY AVERAGE')
 0130              CALL PRTDIS(DIST1.NEV1)
 0131              WRITE(6.302)MNAME([illegible])
 0132          302 FORMAT('1'. 4X.A4.' DISTRIBUTION OF TYPE III DAYS'/7X.
                  *' RIVERSIDE. CHINO. OR REDLANDS - HOURLY AVERAGE')
 0133              CALL PRTDIS(DIST3.NEV3)
 0134              GOTO 1000
 0135         2000 WRITE(6.204)I01.I02.I03.I04
 0136          204 FORMAT('1INPUT SEQUENCING ERROR'.4I9)
 0137         3000 RETURN
 0138              END
```

```
FORTRAN IV G1  RELEASE 2.0             MAIN              DATE = 75254        10/17/09               PAGE 0005

 *OPTIONS IN EFFECT*  NOTERM.ID.EBCDIC.SOURCE.NOLIST.NODECK.LOAD.NOMAP.NOTEST
 *OPTIONS IN EFFECT*  NAME = MAIN    . LINECNT =        54
 *STATISTICS*    SOURCE STATEMENTS =       138.PROGRAM SIZE =    17174
 *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0            PRTDIS               DATE = 75283          10/17/09                PAGE 0001

 0001                  SUBROUTINE PRTDIS(DIST.NUM)
 0002                  INTEGER DIST(31)
 0003                  WRITE(6.199)
 0004              199 FORMAT(/)
 0005                  WRITE(6.200)
 0006              200 FORMAT('      DIFFERENCE  EVENTS       PER CENT   CUMULATIVE PER CEN
                     *T')
 0007                  CUMPCT=0.
 0008                  DO 1 I=1.31
 0009                  PCT=0.
 0010                  IF(NUM.NE.0)PCT=FLOAT(DIST(I))/FLOAT(NUM)
 0011                  CUMPCT=CUMPCT+PCT
 0012                  IM15=I-16
 0013                  WRITE(6.201)IM15.DIST(I).PCT.CUMPCT
 0014              201 FORMAT(1X.2I10.2F15.2)
 0015                1 CONTINUE
 0016                  RETURN
 0017                  END
```

```
FORTRAN IV G1  RELEASE 2.0            PRTDIS            DATE = 75263         10/17/09                  PAGE 0002

 *OPTIONS IN EFFECT*  NOTERM.ID.EBCDIC.SOURCE.NOLIST.NODECK.LOAD.NOMAP.NOTEST
 *OPTIONS IN EFFECT*  NAME = PRTDIS  . LINECNT =       54
 *STATISTICS*    SOURCE STATEMENTS =       17.PROGRAM SIZE =      668
 *STATISTICS*  NO DIAGNOSTICS GENERATED

 *STATISTICS*  NO DIAGNOSTICS THIS STEP



 F64-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED XREF
          DEFAULT OPTION(S) USED -  SIZE=(120832,24576)
****GO          DOES NOT EXIST BUT HAS BEEN ADDED TO DATA SET
AUTHORIZATION CODE IS         0.
```

APR HOURLY VALUES USED

			HOUR																						
		NT	9		10		11		12		13		14		15		16		17		18		19		20		NT
DAY	TYPE		N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	
1	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
2	I	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	2
3	II	2	6	6	7	7	8	8	8	8	8	8	7	7	6	6	5	5	3	3	3	3	2	2	2	2	2
4	I	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
5	I	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
6	I	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
7	I	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
8	I	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	I	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
10	I	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
11	I	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
12	I	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	2
13	I	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	2
14	I	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
15	I	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
16	I	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
17	I	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
18	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
19	II	2	4	4	7	7	7	7	8	8	9	9	8	8	9	9	10	10	10	10	7	7	5	5	3	3	2
20	III	2	7	8	9	12	9	13	10	15	13	19	15	19	18	18	17	16	15	13	11	14	7	14	3	9	2
21	II	2	7	7	9	9	9	9	9	9	7	7	7	7	7	7	6	6	5	5	4	4	4	4	4	4	2
22	I	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
23	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
24	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
25	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
26	I	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
27	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
28	II	2	7	7	8	8	8	8	9	9	10	10	10	10	9	9	8	8	10	10	8	8	6	6	3	3	2
29	III	2	6	7	6	10	6	11	11	15	12	17	13	17	14	14	12	13	10	14	8	10	6	6	4	6	2
30	III	2	8	8	11	7	11	9	12	11	12	11	12	11	10	9	9	9	7	8	6	7	5	7	4	6	2

```
     APR  NIGHT DISTRIBUTION, [illegible]
   DIFFERENCE BETWEEN RIVERSIDE [illegible]

DIFFERENCE  EVENTS      PER CENT   CUMULATIVE PER CENT
   -15         0           0.0          0.0
   -14         0           0.0          0.0
   -13         0           0.0          0.0
   -12         0           0.0          0.0
   -11         0           0.0          0.0
   -10         0           0.0          0.0
    -9         0           0.0          0.0
    -8         0           0.0          0.0
    -7         0           0.0          0.0
    -6         0           0.0          0.0
    -5         0           0.0          0.0
    -4         0           0.0          0.0
    -3         0           0.0          0.0
    -2       213           0.30         0.30
    -1       218           0.31         0.61
     0       164           0.23         0.84
     1        92           0.12         0.95
     2        20           0.03         0.98
     3        12           0.02         1.00
     4         0           0.0          1.00
     5         1           0.00         1.00
     6         0           0.0          1.00
     7         0           0.0          1.00
     8         0           0.0          1.00
     9         0           0.0          1.00
    10         0           0.0          1.00
    11         0           0.0          1.00
    12         0           0.0          1.00
    13         0           0.0          1.00
    14         0           0.0          1.00
    15         0           0.0          1.00
```

ARB DISTRIBUTION OF TYPE 1 DAYS
RIVERSIDE OR CORONA - DAILY AVERAGE

DIFFERENCE	EVENTS	PER CENT	CUMULATIVE PER CENT
-15	0	0.0	0.0
-14	0	0.0	0.0
-13	0	0.0	0.0
-12	0	0.0	0.0
-11	0	0.0	0.0
-10	0	0.0	0.0
-9	0	0.0	0.0
-8	0	0.0	0.0
-7	0	0.0	0.0
-6	0	0.0	0.0
-5	0	0.0	0.0
-4	4	0.01	0.01
-3	24	0.04	0.05
-2	46	0.08	0.13
-1	115	0.21	0.34
0	151	0.27	0.62
1	140	0.25	0.87
2	58	0.11	0.98
3	12	0.02	1.00
4	1	0.00	1.00
5	0	0.0	1.00
6	0	0.0	1.00
7	0	0.0	1.00
8	0	0.0	1.00
9	0	0.0	1.00
10	0	0.0	1.00
11	0	0.0	1.00
12	0	0.0	1.00
13	0	0.0	1.00
14	0	0.0	1.00
15	0	0.0	1.00

ARR DISTRIBUTION OF [illegible]
RIVERSIDE, CHINO, OR REDLANDS - HOURLY AVERAGE

DIFFERENCE	EVENTS	PER CENT	CUMULATIVE PER CENT
-15	0	0.0	0.0
-14	0	0.0	0.0
-13	0	0.0	0.0
-12	0	0.0	0.0
-11	0	0.0	0.0
-10	0	0.0	0.0
-9	0	0.0	0.0
-8	0	0.0	0.0
-7	0	0.0	0.0
-6	1	0.01	0.01
-5	2	0.02	0.03
-4	3	0.03	0.06
-3	4	0.04	0.09
-2	13	0.12	0.21
-1	14	0.13	0.34
0	38	0.35	0.69
1	15	0.14	0.83
2	9	0.08	0.92
3	4	0.04	0.95
4	0	0.0	0.95
5	2	0.02	0.97
6	1	0.01	0.98
7	1	0.01	0.99
8	0	0.0	0.99
9	1	0.01	1.00
10	0	0.0	1.00
11	0	0.0	1.00
12	0	0.0	1.00
13	0	0.0	1.00
14	0	0.0	1.00
15	0	0.0	1.00

MAY HOURLY VALUES USED

HOUR

DAY	TYPE	NT	9		10		11		12		13		14		15		16		17		18		19		20		NT
			N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	
1	II	3	6	6	7	7	8	8	9	9	11	11	11	11	9	9	8	8	7	7	5	5	4	4	4	4	3
2	III	3	8	10	10	15	13	16	14	20	15	23	17	16	17	19	15	14	12	13	9	8	4	4	2	2	3
3	III	3	7	9	10	9	12	10	11	10	10	10	9	9	7	8	6	6	5	5	4	5	3	6	3	6	3
4	I	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
5	I	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3
6	I	3	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	3
7	III	3	7	8	8	10	8	10	9	11	11	14	12	16	12	14	10	10	7	8	6	7	4	5	2	2	3
8	II	3	8	9	9	9	11	11	12	12	13	13	10	10	8	8	8	8	6	6	3	3	2	2	1	1	3
9	III	3	6	7	7	8	11	15	12	16	13	23	16	23	16	24	16	15	12	11	8	8	6	5	2	3	3
10	III	3	10	16	12	19	13	20	14	24	15	23	16	26	16	23	14	17	11	11	9	8	4	4	2	2	3
11	III	3	9	13	10	15	12	14	13	16	9	17	11	17	16	15	14	15	12	14	10	11	7	7	4	5	3
12	III	3	14	17	18	19	19	20	22	22	22	23	19	17	13	14	10	11	7	8	4	5	2	2	1	2	3
13	III	3	6	4	9	8	13	13	16	15	18	16	17	14	14	10	9	6	7	5	5	3	3	3	1	3	3
14	III	3	3	3	5	6	8	10	11	12	15	15	16	15	13	12	11	11	9	10	7	8	5	6	2	4	3
15	III	3	5	5	6	6	9	8	9	10	11	9	11	9	11	10	11	11	9	8	6	6	4	5	3	4	3
16	II	[illegible]	6	6	7	7	7	7	8	8	8	8	7	7	6	6	5	5	5	5	3	3	3	3	2	2	3
17	II	3	9	9	11	11	14	14	17	17	19	19	21	21	19	19	13	13	10	10	7	7	5	5	4	4	3
18	II	3	5	5	7	7	8	8	10	10	10	10	8	8	6	6	5	5	4	4	3	3	2	2	1	1	3
19	I	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
20	I	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
21	I	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3
22	II	3	8	8	9	9	9	9	11	11	11	11	10	10	8	8	6	6	5	5	3	3	2	2	1	1	3
23	III	3	7	5	11	9	13	11	12	15	19	18	18	19	16	16	12	15	11	16	8	14	5	10	1	5	3
24	II	3	6	6	9	9	13	13	12	12	14	14	14	14	13	13	12	12	9	9	9	9	9	8	7	7	3
25	II	3	3	3	7	7	9	9	10	10	11	11	10	10	9	9	7	7	7	7	5	5	4	4	2	2	3
26	II	3	3	3	5	5	8	8	13	13	13	13	16	16	14	14	12	12	9	9	8	8	5	5	3	3	3
27	I	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
28	II	3	7	7	9	9	11	11	13	13	14	14	15	15	13	13	10	10	8	8	8	8	6	6	5	5	3
29	III	3	5	7	7	9	9	11	10	14	7	14	9	13	10	11	10	11	11	10	8	9	6	8	4	5	3
30	III	3	7	6	12	12	13	17	17	26	20	23	23	27	23	27	23	27	15	22	14	15	10	9	7	4	3
31	III	3	7	7	12	11	16	11	17	15	19	17	16	17	16	15	13	11	11	14	11	13	8	8	5	5	3

```
     MAY  NIGHT DISTRIBUTION, BACKGROUND VALUE =  3
   DIFFERENCE BETWEEN RIVERSIDE OR CORONA AND BACKGROUND.

DIFFERENCE  EVENTS       PER CENT   CUMULATIVE PER CENT
   -15         0           0.0            0.0
   -14         0           0.0            0.0
   -13         0           0.0            0.0
   -12         0           0.0            0.0
   -11         0           0.0            0.0
   -10         0           0.0            0.0
    -9         0           0.0            0.0
    -8         0           0.0            0.0
    -7         0           0.0            0.0
    -6         0           0.0            0.0
    -5         0           0.0            0.0
    -4         0           0.0            0.0
    -3       187           0.26           0.26
    -2       178           0.24           0.50
    -1       136           0.19           0.69
     0        87           0.12           0.81
     1        72           0.10           0.90
     2        39           0.05           0.96
     3        17           0.02           0.98
     4         7           0.01           0.99
     5         5           0.01           1.00
     6         0           0.0            1.00
     7         1           0.00           1.00
     8         0           0.0            1.00
     9         1           0.00           1.00
    10         0           0.0            1.00
    11         0           0.0            1.00
    12         0           0.0            1.00
    13         0           0.0            1.00
    14         0           0.0            1.00
    15         0           0.0            1.00
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  MAY  DISTRIBUTION OF TYPE I DAYS
RIVERSIDE OR CORONA - DAILY AVERAGE

DIFFERENCE  EVENTS       PER CENT   CUMULATIVE PER CENT
   -15         0           0.0           0.0
   -14         0           0.0           0.0
   -13         0           0.0           0.0
   -12         0           0.0           0.0
   -11         0           0.0           0.0
   -10         0           0.0           0.0
    -9         0           0.0           0.0
    -8         0           0.0           0.0
    -7         0           0.0           0.0
    -6         0           0.0           0.0
    -5         1           0.01          0.01
    -4         1           0.01          0.01
    -3         5           0.03          0.05
    -2        13           0.09          0.14
    -1        22           0.15          0.28
     0        47           0.32          0.60
     1        39           0.26          0.86
     2        17           0.11          0.97
     3         4           0.03          1.00
     4         0           0.0           1.00
     5         0           0.0           1.00
     6         0           0.0           1.00
     7         0           0.0           1.00
     8         0           0.0           1.00
     9         0           0.0           1.00
    10         0           0.0           1.00
    11         0           0.0           1.00
    12         0           0.0           1.00
    13         0           0.0           1.00
    14         0           0.0           1.00
    15         0           0.0           1.00
```

MAY DISTRIBUTION OF TYPE III DAYS
RIVERSIDE, CHINO, OR REDLANDS - HOURLY AVERAGE

DIFFERENCE	EVENTS	PER CENT	CUMULATIVE PER CENT
-15	0	0.0	0.0
-14	0	0.0	0.0
-13	0	0.0	0.0
-12	0	0.0	0.0
-11	0	0.0	0.0
-10	1	0.00	0.00
-9	0	0.0	0.00
-8	2	0.00	0.01
-7	8	0.02	0.02
-6	9	0.02	0.04
-5	13	0.03	0.06
-4	22	0.04	0.11
-3	29	0.06	0.17
-2	53	0.11	0.27
-1	81	0.16	0.43
0	74	0.15	0.58
1	82	0.16	0.74
2	42	0.08	0.83
3	43	0.09	0.91
4	16	0.03	0.94
5	11	0.02	0.97
6	8	0.02	0.98
7	5	0.01	0.99
8	2	0.00	1.00
9	0	0.0	1.00
10	1	0.00	1.00
11	1	0.00	1.00
12	0	0.0	1.00
13	0	0.0	1.00
14	0	0.0	1.00
15	0	0.0	1.00

JUNE HOURLY VALUES USED

HOUR

DAY	TYPE	NT	9		10		11		12		13		14		15		16		17		18		19		20		NT
			N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	
1	III	2	5	5	9	8	11	12	12	14	13	12	14	10	14	10	13	10	11	8	7	5	5	2	3	0	2
2	III	2	2	2	6	5	9	8	12	12	13	13	14	12	13	9	12	9	9	7	6	5	3	3	2	2	2
3	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
4	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
5	III	2	3	2	5	4	9	9	13	10	14	11	17	15	18	17	16	12	13	11	9	8	5	4	3	2	2
6	III	2	6	4	11	8	14	12	18	15	19	20	19	15	16	13	12	10	9	8	7	6	4	4	2	2	2
7	III	2	6	5	10	8	11	9	13	13	13	16	12	9	11	8	10	7	9	5	7	4	4	3	3	2	2
8	II	2	3	3	5	5	7	7	7	7	7	7	8	8	8	8	7	7	5	5	3	3	2	2	1	1	2
9	II	2	4	4	8	8	11	11	14	14	18	18	18	18	19	19	14	14	11	11	7	7	4	4	4	4	2
10	III	2	8	6	12	13	17	14	19	17	22	19	25	18	24	17	23	16	20	13	16	8	11	5	6	3	2
11	III	2	8	7	13	14	16	18	19	20	20	21	20	27	22	27	23	22	22	18	17	10	9	6	5	5	2
12	III	2	8	6	10	9	14	9	16	10	18	11	18	11	16	11	15	9	11	6	8	5	6	4	5	3	2
13	III	2	6	5	10	10	14	12	17	14	18	13	17	11	15	9	13	7	11	6	10	6	8	5	6	3	2
14	III	2	5	6	10	11	16	13	15	18	19	18	18	17	17	15	14	12	12	10	10	6	7	2	3	1	2
15	III	2	5	5	8	8	12	11	15	11	15	9	14	8	12	7	10	5	8	5	6	4	5	3	4	3	2
16	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
17	I	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
18	I	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
19	I	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
20	I	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
21	III	2	8	8	11	11	12	12	15	15	16	14	16	13	15	13	14	12	11	11	9	8	7	4	4	2	2
22	III	2	6	6	9	10	14	11	15	14	16	15	16	13	16	10	15	8	13	10	11	8	7	6	5	3	2
23	III	2	4	4	7	7	10	9	11	9	12	8	11	8	9	6	7	6	6	5	5	3	3	2	2	1	2
24	II	2	2	2	4	4	6	6	8	8	8	8	10	10	9	9	6	6	6	6	5	5	5	5	4	4	2
25	III	2	7	9	9	10	10	11	11	13	13	15	17	17	18	14	15	9	13	6	9	5	5	3	2	1	2
26	III	2	8	7	10	10	15	11	16	11	17	8	15	8	12	8	13	8	14	9	12	8	7	5	3	3	2
27	III	2	10	3	11	9	14	8	15	10	14	11	15	9	13	8	12	7	10	7	8	5	7	2	4	0	2
28	III	2	9	6	15	7	17	7	15	10	15	12	16	11	15	11	12	9	11	7	9	7	6	7	4	4	2
29	III	2	8	10	14	13	14	11	14	10	14	12	14	11	12	9	10	8	10	7	8	7	5	4	2	2	2
30	III	2	10	10	8	9	8	9	9	11	10	9	8	9	8	10	10	10	10	8	10	9	7	5	4	2	2

```
    JUNE NIGHT DISTRIBUTION, BACKGROUND VALUE =  2
  DIFFERENCE BETWEEN REVERSION TO CURRENT AND BACKGROUND

DIFFERENCE  EVENTS       PER CENT   CUMULATIVE PER CENT
   -15         0           0.0            0.0
   -14         0           0.0            0.0
   -13         0           0.0            0.0
   -12         0           0.0            0.0
   -11         0           0.0            0.0
   -10         0           0.0            0.0
    -9         0           0.0            0.0
    -8         0           0.0            0.0
    -7         0           0.0            0.0
    -6         0           0.0            0.0
    -5         0           0.0            0.0
    -4         0           0.0            0.0
    -3         0           0.0            0.0
    -2       210           0.30           0.30
    -1       227           0.33           0.63
     0       161           0.23           0.87
     1        62           0.09           0.96
     2        18           0.03           0.98
     3         6           0.01           0.99
     4         2           0.00           0.99
     5         2           0.00           1.00
     6         0           0.0            1.00
     7         3           0.00           1.00
     8         0           0.0            1.00
     9         0           0.0            1.00
    10         0           0.0            1.00
    11         0           0.0            1.00
    12         0           0.0            1.00
    13         0           0.0            1.00
    14         0           0.0            1.00
    15         0           0.0            1.00
```

JUNE DISTRIBUTION OF TYPE I DAYS
RIVERSIDE OR CORONA - DAILY AVERAGE

DIFFERENCE	EVENTS	PER CENT	CUMULATIVE PER CENT
-15	0	0.0	0.0
-14	0	0.0	0.0
-13	0	0.0	0.0
-12	0	0.0	0.0
-11	0	0.0	0.0
-10	0	0.0	0.0
-9	0	0.0	0.0
-8	0	0.0	0.0
-7	0	0.0	0.0
-6	0	0.0	0.0
-5	1	0.01	0.01
-4	3	0.02	0.03
-3	8	0.05	0.08
-2	12	0.08	0.16
-1	39	0.26	0.43
0	33	0.22	0.65
1	31	0.21	0.86
2	9	0.06	0.92
3	7	0.05	0.97
4	5	0.03	1.00
5	0	0.0	1.00
6	0	0.0	1.00
7	0	0.0	1.00
8	0	0.0	1.00
9	0	0.0	1.00
10	0	0.0	1.00
11	0	0.0	1.00
12	0	0.0	1.00
13	0	0.0	1.00
14	0	0.0	1.00
15	0	0.0	1.00

JUNE DISTRIBUTION OF TYPE III DAYS
RIVERSIDE, CHINO, OR REDLANDS - HOURLY AVERAGE

DIFFERENCE	EVENTS	PER CENT	CUMULATIVE PER CENT
-15	0	0.0	0.0
-14	0	0.0	0.0
-13	0	0.0	0.0
-12	0	0.0	0.0
-11	1	0.00	0.00
-10	1	0.00	0.00
-9	0	0.0	0.00
-8	0	0.0	0.00
-7	3	0.00	0.01
-6	3	0.00	0.01
-5	8	0.01	0.02
-4	16	0.02	0.05
-3	39	0.06	0.11
-2	77	0.12	0.23
-1	98	0.15	0.38
0	162	0.25	0.63
1	105	0.16	0.79
2	65	0.10	0.89
3	42	0.07	0.96
4	13	0.02	0.98
5	8	0.01	0.99
6	1	0.00	0.99
7	2	0.00	1.00
8	1	0.00	1.00
9	0	0.0	1.00
10	1	0.00	1.00
11	0	0.0	1.00
12	0	0.0	1.00
13	0	0.0	1.00
14	0	0.0	1.00
15	0	0.0	1.00

JULY HOURLY VALUES USED

DAY	TYPE	NT	HOUR 9		10		11		12		13		14		15		16		17		18		19		20		NT
			N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	
1	III	2	8	10	8	10	9	8	11	11	14	11	16	12	17	14	14	12	12	10	9	7	5	3	3	2	2
2	II	2	8	8	11	11	9	9	11	11	12	12	10	10	7	7	7	7	7	7	7	7	4	4	2	2	2
3	III	2	8	7	12	9	14	4	13	9	13	10	11	8	8	6	7	5	6	4	5	3	4	2	3	1	2
4	III	2	7	8	10	13	13	12	14	12	16	13	15	12	14	11	13	9	12	9	10	8	8	7	7	4	2
5	III	2	13	12	13	11	14	12	17	15	19	18	19	15	18	13	16	12	14	11	12	10	9	6	6	3	2
6	III	2	9	8	10	9	12	8	15	9	18	8	18	12	18	12	16	10	12	7	9	5	6	3	2	1	2
7	III	2	7	1	10	1	14	1	16	5	16	9	15	10	15	9	16	15	17	16	16	12	11	7	7	3	2
8	III	2	2	2	5	3	8	5	13	8	16	8	20	10	20	10	19	10	16	7	9	6	5	3	4	0	2
9	III	2	11	11	19	14	21	15	19	17	18	16	18	15	21	14	18	15	19	16	17	15	14	11	10	9	2
10	III	2	17	16	17	15	20	15	23	14	17	10	14	7	11	8	10	7	8	5	7	2	4	1	5	0	2
11	III	2	10	13	13	14	15	17	20	19	23	24	26	19	25	16	20	14	16	14	11	11	9	9	5	4	2
12	III	2	9	10	11	10	13	9	14	10	14	6	12	5	9	4	7	3	5	2	4	2	2	1	1	1	2
13	III	2	3	2	5	4	7	5	9	7	10	8	11	7	10	6	9	4	6	3	5	2	2	1	1	1	2
14	III	2	3	3	5	6	9	8	11	10	13	13	15	13	15	12	14	11	11	8	8	5	5	2	2	1	2
15	III	2	5	5	8	12	13	14	15	15	16	16	16	15	16	15	13	13	11	13	9	10	7	6	6	3	2
16	III	2	10	10	13	11	14	9	13	12	12	11	11	10	11	8	10	6	8	4	6	3	5	2	4	2	2
17	III	2	5	5	6	10	10	10	11	7	9	8	9	6	8	4	4	3	3	2	2	1	1	0	1	0	2
18	III	2	2	2	3	4	6	6	8	7	10	8	10	8	9	6	7	4	5	2	3	1	2	1	1	0	2
19	III	2	5	2	7	5	11	10	14	14	15	17	16	14	15	12	15	12	13	10	10	7	7	4	5	2	2
20	III	2	8	5	12	9	14	11	16	13	16	16	16	13	14	11	15	10	15	11	12	8	9	4	5	1	2
21	III	2	6	7	11	8	17	14	17	16	17	18	18	16	18	14	18	12	17	14	13	11	10	6	6	3	2
22	III	2	9	9	15	15	15	16	15	15	14	15	15	13	17	10	16	9	14	7	11	8	7	5	5	2	2
23	III	2	9	10	14	15	14	13	14	13	17	11	15	10	14	9	13	7	11	5	8	2	6	0	3	0	2
24	III	2	8	8	14	15	19	16	20	17	21	18	23	17	15	10	11	9	10	7	8	4	5	1	3	0	2
25	III	2	6	10	11	15	16	16	18	20	26	21	28	23	28	23	30	22	26	18	20	14	14	9	7	5	2
26	III	2	11	5	16	5	17	7	19	9	18	11	18	10	16	9	11	9	10	6	7	3	6	2	3	1	2
27	III	2	9	7	10	6	12	7	12	8	11	6	10	5	8	4	7	3	7	2	5	1	4	0	2	0	2
28	II	2	1	1	2	2	3	3	5	5	8	8	10	10	14	14	16	16	11	11	7	7	3	3	2	2	2
29	III	2	6	-1	9	-1	10	-1	11	-1	10	6	9	5	8	4	7	3	6	2	4	1	3	0	2	0	2
30	III	2	3	2	4	4	6	5	8	6	9	6	9	5	8	4	7	4	6	3	5	2	3	1	2	1	2
31	III	2	5	6	7	6	8	10	12	16	16	17	23	14	23	13	16	10	16	8	11	5	9	4	6	2	2

```
     JULY NIGHT DISTRIBUTION, BACKGROUND VALUE =  2
   DIFFERENCE BETWEEN RIVERSIDE OR CORONA AND BACKGROUND

 DIFFERENCE  EVENTS        PER CENT   CUMULATIVE PER CENT
    -15         0            0.0            0.0
    -14         0            0.0            0.0
    -13         0            0.0            0.0
    -12         0            0.0            0.0
    -11         0            0.0            0.0
    -10         0            0.0            0.0
     -9         0            0.0            0.0
     -8         0            0.0            0.0
     -7         0            0.0            0.0
     -6         0            0.0            0.0
     -5         0            0.0            0.0
     -4         0            0.0            0.0
     -3         0            0.0            0.0
     -2       354            0.49           0.49
     -1       225            0.31           0.79
      0        60            0.08           0.88
      1        33            0.05           0.92
      2        21            0.03           0.95
      3        10            0.01           0.96
      4        11            0.02           0.98
      5         5            0.01           0.99
      6         4            0.01           0.99
      7         3            0.00           1.00
      8         1            0.00           1.00
      9         0            0.0            1.00
     10         1            0.00           1.00
     11         0            0.0            1.00
     12         0            0.0            1.00
     13         0            0.0            1.00
     14         0            0.0            1.00
     15         1            0.00           1.00
```

JULY DISTRIBUTION OF TYPE I DAYS
RIVERSIDE OR CORONA - DAILY AVERAGE

DIFFERENCE	EVENTS	PER CENT	CUMULATIVE PER CENT
-15	0	0.0	0.0
-14	0	0.0	0.0
-13	0	0.0	0.0
-12	0	0.0	0.0
-11	0	0.0	0.0
-10	0	0.0	0.0
-9	0	0.0	0.0
-8	0	0.0	0.0
-7	0	0.0	0.0
-6	0	0.0	0.0
-5	0	0.0	0.0
-4	0	0.0	0.0
-3	0	0.0	0.0
-2	0	0.0	0.0
-1	0	0.0	0.0
0	0	0.0	0.0
1	0	0.0	0.0
2	0	0.0	0.0
3	0	0.0	0.0
4	0	0.0	0.0
5	0	0.0	0.0
6	0	0.0	0.0
7	0	0.0	0.0
8	0	0.0	0.0
9	0	0.0	0.0
10	0	0.0	0.0
11	0	0.0	0.0
12	0	0.0	0.0
13	0	0.0	0.0
14	0	0.0	0.0
15	0	0.0	0.0

JULY DISTRIBUTION OF TYPE III DAYS
RIVERSIDE, CHINO, OR REDLANDS - HOURLY AVERAGE

DIFFERENCE	EVENTS	PER CENT	CUMULATIVE PER CENT
-15	3	0.00	0.00
-14	0	0.0	0.00
-13	0	0.0	0.00
-12	0	0.0	0.00
-11	1	0.00	0.00
-10	2	0.00	0.01
-9	5	0.00	0.01
-8	3	0.00	0.01
-7	3	0.00	0.02
-6	14	0.01	0.03
-5	21	0.02	0.05
-4	32	0.03	0.08
-3	56	0.05	0.14
-2	92	0.09	0.23
-1	147	0.14	0.37
0	202	0.20	0.57
1	171	0.17	0.73
2	131	0.13	0.86
3	72	0.07	0.93
4	37	0.04	0.97
5	13	0.01	0.98
6	9	0.01	0.99
7	4	0.00	0.99
8	5	0.00	1.00
9	1	0.00	1.00
10	0	0.0	1.00
11	0	0.0	1.00
12	0	0.0	1.00
13	0	0.0	1.00
14	0	0.0	1.00
15	0	0.0	1.00